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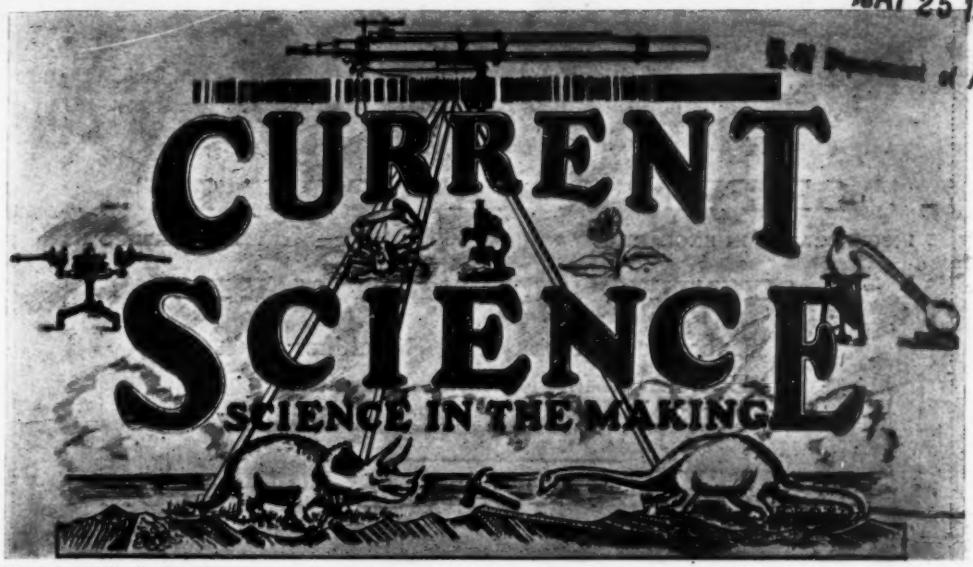

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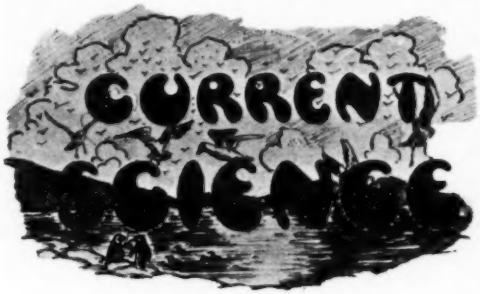

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CONTENTS.

Examinations and Education.

ONE of the reasons why examinations have acquired a vicious influence and undue importance in some of the Indian universities is that they constitute the only avenue for preferment in government service and more recently other employing agencies also have begun to appreciate the value of higher education in their servants. This intimate association of a purely academic function with the economic and service problems must necessarily produce a baleful effect upon both. The vision of an educated young man is restricted by the four walls of the office room and he devotes all his energies to pass his examination for the realisation of his modest ambitions. Government should have at their disposal means other than the university examinations for discovering those qualities in their employees for the proper and efficient performance of administrative duties but the touching confidence they have all along reposed in the universal efficacy of these tests is a credit to the honesty of the whole transaction. This relationship has unfortunately exposed the system of education and examination to the unmerited criticism that they are a cause of the evil of unemployment among the educated young men. In India failure in an examination amounts almost to forfeiture of one's social status and the young men whom the universities reject annually have no alternative except to pass through life like a perpetual blister. The remedy seems to be to throw open those services for their absorption, which are at present treated as close preserves and to encourage settlement on the land, to promote cottage and minor industries and to facilitate emigration.

The prevailing dissatisfaction and the public criticisms which we repeatedly hear in regard to examinations will on ultimate analysis be found to lie in three defects which have unconsciously been permitted to creep into the system. Those who are conversant with the history of education in India might remember that in Tols and Patasalas, there was abundance of good learning but little or no examinations. In the ancient universities of India, the process of weighing knowledge attained by the scholars used to take the form of disputations among themselves, in which they were permitted to engage under the presidency of their teacher and in

accordance with the well-known rules of debate. Viewed from any standpoint, an examination is essentially in the nature of a contest. If this view be correct then it follows that justice and fairplay require that the scholars themselves should be permitted to find out the profundity or otherwise of each other's learning and the function of the teacher should be restricted to the maintenance of the standard and the appropriate rules of disputation. The professor in the ancient universities did not enter actively into these literary contests for he was conscious that his vast store of learning and his highly sophisticated mind with its powers of defeating the opponent would be unfair implements to be used against young and growing minds and the whole engagement would be unnatural. In our present-day academic tests we are employing methods which can never be permitted in physical contests and athletic sports. Our public examinations are not different from a five days' cricket test match in which a hundred youthful players are gathered at Lords, trained for four years in different centres by coaches whose skill and proficiency are not of the same order and under conditions of equipment never uniform. These young men are called upon to defend their wickets and in a single over are required to hit boundaries against professional bowlers who however are asked to adjust the pace, length and spin of the ball to the level of the skill and attainment of the juvenile team. These bowlers constitute themselves into referees to declare l.b.w., decide boundary hits and all other intricate and delicate problems in the decision of which one of the parties is to maintain absolute silence and to give unquestioning acquiescence. If this is a fair game then the university examinations are only artistic perfections. The examiner enters the lists throwing out the challenge of a question paper to be picked up by the young aspirants for laurels; he determines the rules and declares the issues of the contest and it is no wonder that the young men treat it all as a game of manœuvres in which they employ all the instruments which their external supporters have placed in their hands for confounding their assailant. The system which we have evolved is inevitable in view of the magnitude of the material to be dealt with and the speed and simultaneity of action involved. Its merit perhaps is that it is impersonal in its dealings and uniform in its applications. However, it cannot escape the charge that for purposes of measuring the amount of intellectual proficiency that the young man has acquired during his four years' training, we have introduced weights which are of a totally different order and which always succeed in discovering the want of knowledge. We have travelled far too great a distance in organizing our educational institutions to be able to restore the more natural scheme of examinations once prevalent in the ancient universities.

Perhaps a graver defect of our existing system is the negative correlation of the age of the pupils and the total amount of knowledge they are required to bring up for the examination. A candidate whose age is eighteen years and who appears for the degree examination is expected to read about twenty books (and more in the case of an intermediate candidate) and to acquire complete and detailed knowledge of every one of them to be ready to be reproduced at a given moment in an ideal form. We forget that the contents of each book represent a body of knowledge in the building of which several adult minds have laboured incessantly over long periods of time and if the author of the book were required to sit for an examination it is doubtful if he will get the necessary minimum mark. In fact we are asking the young men to perform a task which it has taken the human race ages of unremitting work to complete and to consolidate. The examiners besides have little patience with the candidates when they commit errors and it would be unnatural for a young man not to do so, for a growing mind must necessarily trace the lines along which the racial mind has travelled in the quest of knowledge. The history of the rise and growth of science reveals the fact that adult minds were not infallible and if we excuse the mistakes made by experienced adult minds working in a free atmosphere, with plenty of leisure and all the resources of reference and personal consultations, what justification have we to reject the candidates for committing similar errors which are inevitable in the feverish state of their mind working unassisted against time? Public examinations make little allowance for, nor recognise the biological history of the human mind and the arbitrary standards we have set up for the young men will stagger the authors themselves and in almost every case if the question paper setter were required to

answer his own paper within the limited time permitted to the candidates, it is doubtful if when his answer scripts are valued by his colleagues, he will get marks sufficiently high to place him in the first division.

Another defect which is perhaps inseparable from the existing conditions is the medium of instruction and examination. All the energy of the Indian student is spent in acquiring mastery over a foreign language and very little is left to develop a deep acquaintance with the subject-matter. From this handicap, his cousins elsewhere are exempt. This must account for the very superficial knowledge which the bulk of the candidates present at the public examinations and in marking their papers no allowance is made for the inadequacy of expression due to a fundamental defect in the organization itself. In India where there is a multiplicity of languages, the problem of instituting a common medium of instruction and examination is really fraught with difficulties arising from various causes. But if her people are determined to place their country in the forefront along with others which lead in the world of science and education, they must sacrifice sentiment and put aside all other considerations than those of the true interests of the nation. A common language for imparting instruction to the youth of the country is possible provided the people will to adopt it and in case they are to decide in favour of that virile and widely spoken language, Hindi, then the commencement should be made in the lowest grades of instruction and books in all branches of knowledge would have to be written. This is almost a task of insuperable difficulty but if the cause is good enough, the trouble alone should not deter its being undertaken. If, however, the psychologists were to prove that Hindi would offer the same difficulties to the non-Hindi pupils as English presents to both, then we have to revert to the days when in South India, English was used in the instruction of all subjects excepting the vernaculars in the middle school grade and endeavour to improve the methods of teaching in such a way as will reduce the obstacles to the acquiring of mastery over it for purposes of free and full expression. The difficulty in assimilating a foreign language is not inherent in it nor is it that an Indian student lacks power to master it but it arises entirely from faulty methods of teaching, the prescription of unsuitable books and perhaps also in some cases from want of competence on the part of the teachers.

At present the undue importance attached to examinations and the unpsychological methods in which they are conducted are exercising a pernicious influence on education which is frequently adjusted to comply with the requirements of their arbitrary standards. The improvements of education are always conceived in terms of the examinations which are considered to be its fitting conclusion. It is the common experience of all Universities that where examinations are permitted to direct and dominate their activities, post-graduate work on the part of such universities tends to counteract. It ought to be possible to strip the Indian university examinations of the terrible aspect which they now wear and make them a part of the regular educational work as they have done in America and most of the European countries. A great and radical reform of examinations is overdue and we feel that this task ought to be entrusted by the Indian Government to the hands of a Commission of educational experts.

One of the reforms that we are thinking of at the present moment refers to the practical examinations in scientific subjects for the B.A. and B.Sc. Pass Degrees and the Intermediate subjects in which practical examinations are conducted. The prevailing practice of assigning an independent problem to be worked out by separate candidates taking physical sciences or a common problem as in the case of those electing biological studies, is unsound as an educational principle. The requirements of the Honours candidates who take a more specialised course over a more prolonged period are different, for their scientific outlook and their intensive training demand evidence of a capacity for continuous application in the investigation of a special problem or the elucidation of complex structural relation in the material provided, including the presentation of a scientific report on the collections of specimens. The scientific courses prescribed for the ordinary pass degree aim at a cultural training while the Intermediate stage attempts at an illuminating general introduction to science. The practical examinations for these candidates ought to be devised to test their acquaintance with the general use of

apparatus, their principles of construction, their working parts and how they are fitted for the purposes for which they are intended, with taking readings, testing and handling particular parts, making connections and so forth. While dealing with the range of the practical acquaintance of each of these assembled pieces of apparatus the examiner has the invaluable opportunity of testing the mental alertness of the candidates whom he takes through an easy *viva voce* examination as well. Similarly in the biological studies, the use of several instruments and how and when to employ them, the identification of specimens with a short account of their structure, habits and modes of occurrence and the description of gross and microscopic preparations will reveal the potentialities of the candidates' mind which the prescription of a definite problem will fail to discover. The scope of the practical examination should be limited to testing the knowledge of the candidates of the apparatus in common use in the laboratory, their manipulative skill and truthfulness in recording results of observed facts. If this system in some form were found desirable to be adopted in regard to Honours examinations, the candidates should be required to give evidence of their power of adopting new methods in the use and application of the instruments and of drawing general conclusions from a mass of experimental data or field notes and observations with a view to test whether the mind works in routine or is capable of devising new methods in dealing with altered situations.

The influence that examinations now exercise on the destiny of education will relax the moment the government and other employing agencies cease to look upon them as a *sine qua non* for employment in their services. It is true that a specialised knowledge of any narrow field of science such as an Honours graduate possesses may not be of direct use in the discharge of the administrative duties, but what is invaluable in him is the disciplined training, the mental alertness and the power of applying scientific knowledge to the problems of government and those of the practical affairs of the people. Admirable as these qualities are, they are not enough in an administrator who needs wisdom, foresight, driving power, ability to command men, to organise and consolidate the forces of civic life and finally the power to take quick and correct decisions and most important of all a natural sweetness of temper. The competitive examinations which are only duplicates of university examinations are, when applied to discover these traits of character, undoubtedly a bad test. Examinations on prescribed books or on definite fields of knowledge can be easily and successfully met by resorting to the aids provided by the ingenuity of commentators and annotators. What the competitive examinations really test is not the knowledge or intelligence, much less any of the personal qualities of the candidate but the amount of cunning with which he can anticipate the questions and provide the examiner with information crammed from 'tips'. There can possibly be nothing better than a wise education for the making of public servants but little can be said in extenuation of an employing agency which requires the best public service and applies the wrong tests for securing it. Is it impossible for the Government to devise a scheme other than competitive examinations for the purpose of selecting competent and wise public servants? The merit of a competitive examination is not the logic or the fairness of it but its power to fulfil the purpose for which it is instituted. Ostensibly the university examinations are intended to test the power to think on the part of the candidates but, generally speaking, the question papers succeed in finding out how much of literary and scientific lumber is stored in the mind and is capable of being unpacked. The Public Services Commission attempt nothing better. We cannot go back to the system of nomination which is attended by fear and distrust, but probably a scheme in which the co-operation of the university professors is enlisted may be found more satisfactory. A panel of distinguished graduates who have shown a distinct aptitude for sports and have taken a leading part in the activity of the university unions may be prepared by the collaboration of the professors of each of the universities for submission to the Public Services Commission who will proceed to invite such nominees for an interview for a detailed *viva voce* examination intended to test those very qualities which the Government would desire in their administrators. If this examination be sufficiently searching and exhaustive the Public Services Commission would succeed in securing for the Government a band of capable officers distinguished alike for their academic scholarship and

administrative qualities. The meaningless duplication of the university examinations can then be dispensed with, resulting in financial saving.

The problems of reforming the public examinations conducted by the universities and by other educational bodies must in their nature be numerous and complicated and would be a fitting subject for detailed investigation by a Commission to be appointed by the India Government. It is true that education is a provincial subject but its importance is an all-India question. The urgent need of assigning examinations to their proper place in the household of education where they are now playing the part of a parvenu mistress is to be recognized. We hope to be able to indicate in a future issue of our Journal the broad outlines on which the reform is to proceed.

Announcement.

Sir C. V. Raman, Kt., M.A., D.Sc., LL.D., F.R.S., N.L.

WE have pleasure in offering our felicitations to Sir C. V. Raman on the occasion of his assuming charge of the Directorship of the Indian Institute of Science, Bangalore. We hope that in augmenting the high traditions of the exalted office he is called upon to occupy, his administration of this important scientific Institution in India will witness a rapid and uninterrupted growth of fresh scientific research conducive to the general progress and industrial prosperity of the country.

The Everest Expedition.

THE successful test flight over Mount Everest by the Houston expedition will always rank as one of the magnificent achievements in the history of aviation. As a public demonstration of the British spirit of enterprise and as a deed of daring, it surpasses in interest and in romance the great enterprises of Peary and Scott. But nevertheless these undertakings cannot be compared with the maritime discoveries of the Italian sailors and the English seamen of the sixteenth century, which opened up the economic resources of vast continents for exploitation by the civilized European nations, converted the impassable oceans into commercial highways and paved the way for the spread of knowledge and civilization, besides adding to our knowledge of the human races, the fauna and flora and the geological conditions of the hitherto unknown tracts of the world.

The previous expeditions on land have not succeeded in attaining the summit of Mount Everest and the flight therefore over this highest peak is attended by more than usual interest. The Westland 'planes used by the party are provided with every equipment which modern science can devise and human resources can supply. The problems of flying in the higher altitudes are severely exacting and unexpected developments in the weather conditions may frustrate the hopes raised by the completeness of equipment, the foresight, efficiency and experience of the party. The fierce hurricanes and the poor visibility in the higher altitudes are factors which no pre-vision or calculation can provide for on account of our imperfect knowledge of the meteorological conditions and the range of their variation in upper atmosphere. The problem of warming food and the kind and quantity of nutrition required for keeping the party fit for carrying on the scientific observations have been carefully thought out and amply provided for. If the air party can establish communications and collaborate with the expedition on foot under the leadership of Mr. Rutledge the scientific results of this undertaking will be of inestimable value. It is too premature to estimate their importance or to envisage the directions in which they may be of practical value. But the knowledge gained by the behaviour of the 'planes in upper air will be of immediate assistance in perfecting the civil aviation for the promotion of peace and goodwill among the nations of the world. It is chiefly in this direction that we look forward to suggestions being made by the Houston party with a view to facilitate easy, cheap and safe communication between nations of the different countries for the consolidation of the higher destinies of humanity.

Dr. M. O. Forster and the Indian Institute of Science.

THERE is a basis of truth in the philosopher's exclamation—"Blessed is the country which has no history!" During the ten years of Dr. Forster's Directorship the Indian Institute of Science has pursued its peaceful way. There have been no students' strikes or political troubles, and a visitor to the annual gymkhana prize-giving sees nothing but happy faces and generous camaraderie. Some 400 students, including those at present in residence, have passed through the Institute during these ten years. It is no small thing that these young men go out into the world, most of them to fill responsible appointments, all imbued with sane and helpful ideals. When all is said it is probably for this that Dr. Forster's name will be remembered with honour and affection. Always accessible, always sympathetic, with an unfailing sense of humour, and scrupulous honesty, it is probable that his left hand does not know what his right hand has done. The warmth of kindly feeling shown at the recent farewell entertainment was unmistakeable.

Dr. M. O. Forster.

While emphasising these things there is much of obvious progress to record. The greatest advance has been in the Department of Electrical Technology, mainly owing to the zeal and initiative of Prof. Catterson-Smith. Wireless laboratories have been equipped and a high tension laboratory and transformer room have been provided, as well as a direction-finding hut, new rooms for battery and charging equipment and a new drawing office.

The number of students has increased from 15 to 53 and the members of the staff from 3 to 8.

The Department of Biochemistry has also developed, the number of students having increased from 16 to 31. A pot-culture house, animal house, insectory and micro-analytical laboratory are among the extensions to the equipment of the Department.

The Departments of General and Organic Chemistry still retain their supremacy in numbers, the students having increased from 52 to 58 and the staff from 4 to 8. Extensions in building and equipment have also taken place.

Through the generosity of Sir Dorab Tata, a Students' Gymkhana Club House has come into being and is the centre of the social life of the Institute.

All these things, by whomsoever originated, demand for their successful carrying out constant attention and support from the Director. He too must exercise watchful care over important concerted researches, such as the investigations on Lac and on the Spike Disease of Sandal, undertaken by the Institute for the Governments of Mysore and Madras respectively.

As his own personal contribution to the scientific work of the Institute must be specially mentioned Dr. Forster's editorship of the *Journal of the Indian Institute of Science*. 165 parts of the Journal have been published during his term of office, each of which he has edited with meticulous care. In this way he has kept close watch over all the scientific work turned out from the laboratories, and has been able to impress his own high standards of excellence upon staff and students alike. At the close of his tenure of office he has lent his support to the new journal *Current Science* which, while appealing to the scientific public of the whole of India, has its birthplace and headquarters at the Institute.

In brief then we may say that Dr. Forster hands over to his successor, Sir C. V. Raman, an institution full of life and possibilities, in good status, socially, scientifically and financially. The foundations have been well and truly laid, what will the superstructure be?

Hyperfine Structure of Elements in Mercury Arc—II.

NUCLEAR MOMENT OF CAESIUM.

By Prof. B. Venkatesachar, M.A., F.Inst.P., and L. Sibaiya, B.Sc., A.Inst.P.

BAINBRIDGE (*P.R.*, **36**, 1668, 1930) has confirmed the earlier results of Aston (*P.M.*, **42**, 436, 1921) regarding the isotopic constitution of cæsium, *viz.*, that it has only one isotope of mass number 133. The source of discrepancy between the simple isotopic constitution of cæsium and its chemical atomic weight cannot be definitely traced until the packing fraction is correctly determined. The hyperfine structure analysis, however, is greatly simplified by the fact that cæsium atoms are all of one class with mass number 133, and no complications arising from a mixture of isotopes are at all possible. Jackson (*P.R.S.*, **121**, 432, 1928) first surmised the nuclear spin moment of cæsium to be either $\frac{1}{2}$ or $\frac{3}{2}$ in units of $\frac{h}{2\pi}$. But according to Kopfermann (*Naturwiss.*, **19**, 676, 1931) the nuclear spin is $\frac{7}{2}$ or $\frac{9}{2}$, while Schutz (*Naturwiss.*, **19**, 1007, 1931) gives for the nuclear moment $\frac{5}{2}$ as the most probable value. Thus to the nucleus of cæsium atom have been ascribed by various observers all the half integral values ranging from $\frac{1}{2}$ to $\frac{9}{2}$. White (*P.R.*, **35**, 411, 1930) however concludes that $\frac{5}{2}$ is probably the correct value from the meagre evidence obtained from the equation

$$\frac{\Delta\nu_g}{\Delta\nu_f} = \frac{m_k}{4\,i\,m_e}$$

connecting the nuclear moment i with the gross structure separation $\Delta\nu_g$ of ^{2}P levels, the electronic mass m_e, the nuclear mass m_k, and the fine structure separation $\Delta\nu_f$ supposed to be equal for both the $^2P_{\frac{1}{2}}$, $^2P_{\frac{3}{2}}$ levels. Jackson gives that

$$\frac{\Delta\nu_f}{\Delta\nu_g} = \frac{1}{\frac{1}{2}Z}\frac{\mu_k}{\mu_e}$$

where μ_k and μ_e are the nuclear and electronic magnetic momenta respectively; whence it follows that the individual separations of the hyperfine levels of ^{2}P states are unresolvably small if we assume that $\frac{\mu_k}{\mu_e}$ is of the order of 10^{-3} after Kopfermann.

The value of the nuclear quantum number can be determined quite simply from the intensity ratio of the components of the hyperfine structure doublets. The CsI doublet $6^2S_{\frac{1}{2}} - 7^2P_{\frac{1}{2}}$, $_{\frac{3}{2}}$ (4593 Å and 4555 Å) gives two components for each line and from their relative intensity the nuclear spin can be estimated. By applying Burger and Dorgelo's intensity rule for gross multiplets to fine multiplets by the substitution of f for j, and considering the fine structure levels of $^2P_{\frac{1}{2}}$, $_{\frac{3}{2}}$ to have negligible separations, the intensity ratio of the two components becomes $\frac{i+1}{i}$ agreeing with the value obtained by Fermi from quantum mechanical considerations. In cæsium the two components have been found to be of very nearly equal intensity, so that the value of i must be high; Jackson (*Nature*, **127**, 924, 1931) says "it may well be $\frac{9}{2}$, or perhaps higher".

Since the normal atoms of cæsium can absorb $6^2S_{\frac{1}{2}} - m^2P_{\frac{1}{2}}$, $_{\frac{3}{2}}$ the effect of absorption in the source on the relative intensity of the hyperfine components needs special mention. Since the ratio $\frac{\text{emission}}{\text{absorption}}$ is the same for both the components of any one line, the stronger component will be more suppressed than the weaker one and the intensity of the two components will be rendered nearly equal as a result of the existence of self-absorption in the source. Filippov and Gross (*Naturwiss.*, **17**, 121, 1929) mention that in their source as well as in the one used by Jackson the possibility of self-reversal is not ruled out. Hence arises the necessity for re-examining the structure in a source where the effect of self-reversal is considerably reduced if not entirely eliminated. With this end in view the radiation from a vertical cooled mercury arc lamp with a tungsten anode containing a small quantity of cæsium chloride is analysed. The source answered our expectations since the use of cæsium chloride in an atmosphere of mercury vapour resulted in the great reduction of normal cæsium atoms responsible for the absorption as compared with other modes of excitation. Again the influence of the inner atomic electric fields on the radiating atoms is more marked in cases where the neighbouring atoms are in the same spectroscopic state as the radiating atoms and belong to the same element. Since the mutual influence is thus great in like atoms, an atmosphere of mercury vapour will serve to

greatly diminish the broadening effect. An analysis of the lines 4593 Å and 4555 Å by Hilger Lummer plates revealed each line as a doublet consisting of two sharp lines with a clear intensity difference. Fig. 1 shows

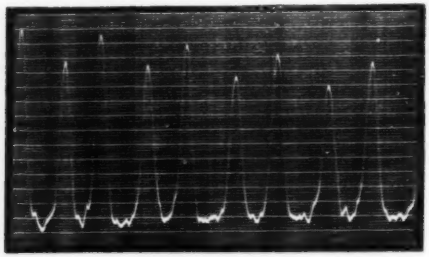

Fig. 1.

Microphotogram of the CsI Line λ 4555 Å, $6\ ^2P_{3/2} - 7\ ^2S_{1/2}$.

the densitometer curve of the Lummer plate pattern of the line 4555 Å taken on a Cambridge Microphotometer by Dr. A. L. Narayan of the Kodaikanal Solar Physics Observatory.

The intensity ratio of the components has been computed by using the Schwarzchild-Stark formula for the darkening D of a photographic plate that

$$D = \log k\, I^m t^n$$

where I is the absolute intensity of the radiation and t the time of exposure, k, m and n being constants depending only on the photographic plate and the wavelength of the radiation. Neglecting the wavelength difference between the components so far as its effect on the sensitiveness of the photographic plate is concerned, we obtain for the two components, whose darkenings are D and D′ and absolute intensities I and I′ that

$$\frac{I'}{I} = e^{\frac{D'-D}{m}}$$

the time of exposure for the two components being necessarily the same. The plate constant 'm' can next be evaluated by photographing the multiplet line with different slit widths for the same intervals of time, and assuming that the absolute intensities are proportional to the slit widths. An alternative method would be to determine 'm' from a hyperfine pattern of known intensity ratio obtained on the same plate, the wavelength of the line employed being as near as possible to that of the line under investigation. A calculation of the relative intensities of the two components from the densitometer curve has given a mean value of $1{\cdot}408 \pm 0{\cdot}018$. Hence the nuclear spin of cæsium can be estimated to be $\frac{5}{2}$; the theoretical value of the intensity ratio as given by the relation $\frac{i+1}{i}$ would then be 1·4. The neighbouring values of nuclear spin, *viz.*, $\frac{3}{2}$ or $\frac{7}{2}$ would give the theoretical ratio as 1·667 or 1·286 respectively, both of which are well outside the observed value. From measurements on the lines $6^2S_{\frac{1}{2}} - 7^2P$, the separation of the $6^2S_{\frac{1}{2}}$ term has been calculated to be 0·298 cm^{-1}, agreeing with value obtained by other observers. Fermi (*Z.P.*, **60**, 320, 1930) has shown that this separation

$$\Delta\nu = 146\, \frac{\mu_k}{\mu_e}\, \frac{2i+1}{i}$$

whence $\frac{\mu_k}{\mu_e} = \frac{1}{1180}$

in agreement with the assumption made by Kopfermann. Applying Nile's correction (*P.R.*, **38**, 375, 1931) to the Fermi formula, the Lande g (I) factor of the cæsium nucleus becomes 1·11. In the case of cæsium where the 6s optical electron alone is responsible for the term $^2S_{\frac{1}{2}}$, its relatively large separation as compared with that of ^2P terms is due to the extreme penetration of the 6s electron in consequence of which the coupling is very strong. The 6p electron is less penetrating, and hence the coupling is far weaker thereby producing only a very small separation in the ^2P levels.

Since the nuclear spin of cæsium has here been determined by applying the gross multiplet intensity rule for hyperfine structure components, it may be pointed out that the intensity ratio of the doublet lines 4555 Å and 4593 Å deviates considerably from the intensity rule for multiplets. Hagenow and Hughes (*P.R.*, **30**, 284, 1927) give ratios ranging from 2·3 : 1 to 3·8 : 1, the higher ratio being obtained with more attenuated sources where one would expect from Burger and Dorgelo's rule an asymtotic approach to the ratio 2 : 1. Filippov (*Z.P.*, **36**, 477, 1926) obtains an average intensity ratio of 3·81 : 1 for this doublet when the weakest possible concentration of the salt was used. Kohn and Jakob (*P.Z.*, **27**, 819, 1926) give ratios ranging from 3·43 : 1 to 4·25 : 1. Though the intensity

rule is thus often violated in the gross structure multiplets, the hyperfine intensity rule has been applied with confidence to the patterns of those very lines that neither obey the intensity rules nor follow LS coupling. If a breakdown of the intensity rule in hyperfine structure should however occur in any single case, the estimate of the nuclear spin of cæsium will have to be established from entirely different considerations such as the Paschen-Back effect or the percentage polarisation of resonance radiation. The observed patterns of the two lines show a wing towards the shorter wavelength side of each component and if this wing be attributed to the small ^2P fine separations, it follows that the fine levels of $7^2P_{\frac{1}{2}}$, $\frac{3}{2}$ are possibly inverted, those of $6^2S_{\frac{1}{2}}$ remaining regular (Fig. 2). The wings of

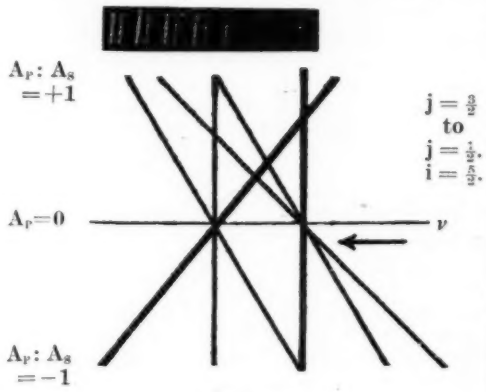

Fig. 2.

Graphical analysis of the structure of CsI 4555 Å, $6\ ^2S_{1/2} - 7\ ^2P_{3/2}$, showing that the observed pattern which fits into the diagram along the arrow is consistent with the inverted fine levels for the term $^2P_{3/2}$ with very small separation. A_p and A_s refer to the interval factors of the P and S states respectively.

the components of 4593 should then be expected to be more pronounced than those of 4555 Å, for according to Fermi

$$\frac{\Delta\,^2P_{\frac{1}{2}}}{\Delta\,^2P_{\frac{3}{2}}} = 2.5$$

a relation which is however violated in the Tl I spectrum. Since in this investigation the chief point was the calculation of the relative intensity of the components, exposures for the patterns were necessarily insufficient to bring out the new faint satellites, if any, as in the case of cadmium or thallium (Venkatesachar and Sibaiya, *Cur. Sc.*, **1**, 264, 1933). Our earlier suggestion that such "faint satellites may be caused by isotopes present in such small relative abundance that the mass-spectrograph has not been able to reveal them" is further supported by the recent discovery of a large number of new isotopes for bismuth, lead and thallium by Miss Bishop and her collaborators (*P.R.*, **43**, 43, 1933) using a magneto-optic method.

Discussion on alkali nuclei :—The nuclear spin of cæsium from the intensity measurements on the hyperfine components is seen to be $\frac{5}{2}$. Using a source similar to the one described above in the case of sodium, each of the D lines have been found to be doublets with a separation of 0·058 cm^{-1} and an estimated intensity ratio of 3 : 1. This would mean that the nuclear spin of sodium is $\frac{1}{2}$, in entire agreement with the conclusions of Frisch and Ferchmin (*Naturwiss.*, **18**, 866, 1930) and Murakawa (*Tokyo Sc. Papers*). But the value $i = \frac{1}{2}$ gives theoretically 33·3% polarisation of resonance radiation, while Ellett's observed value (*P.R.*, **35**, 588, 1930) of 16·3% can only be explained if i is assumed to be equal to 1; again the band spectral data of Na_2 lead us to suspect that the nuclear spin is greater than 2. Thus the spin value determined by the intensity rule is not in agreement with that obtained by the polarisation of resonance radiation or by the band spectral calculations. In potassium also Loomis and Wood (*P.R*, **38**, 854, 1931) point out that "the phenomenon of alternating missing lines not occurring disproves the assertion, based on the failure of certain observers to find hyperfine structure, that the nuclear spin of K 39 is zero." In rubidium, on the other hand, Jackson (*Nature*, **128**, 31, 1931), using an eye-estimate of the intensity ratio of the components as 2 : 1, gives the nuclear spin of Rb 85 as $\frac{3}{2}$, while it could well be 1 in agreement with theory; he attributes the wings of the hyperfine components towards the violet to the heavier isotope Rb 87. Kopfermann (*Naturwiss.*, **21**, 24, 1933) has concluded that the nuclear spin of Rb 85 is $\frac{5}{2}$, while that of Rb 87 is either $\frac{3}{2}$ or $\frac{5}{2}$, and shows that the magnetic moment of Rb 87 is 2·3 times greater than that of Rb 85. Li 6 has a nuclear moment of 0, while that of Li 7, according to the hyperfine structure data of Schüler and Brück (*Z.P.*, **58**, 735, 1929) and Schüler

(*Z.P.*, **66**, 431, 1930), is $\frac{1}{2}$; Harvey and Jenkins (*P.R.*, **35**, 789, 1930) conclude from band spectra that nuclear spin of Li 7 is $\frac{3}{2}$. It must be admitted with Gamow that "the results obtained from the band-spectra on the one hand and from hyperfine structure on the other do not always agree; these inconsistencies may be due to the uncertainty of the experimental data, or to the wrong interpretation of the observed facts."

It is suggested that the nucleus consists of a maximum number of α-particles, one proton or none, and neutrons with spin moments of $\frac{1}{2}\frac{h}{2\pi}$ arranged in shells (Venkatesachar and Subbaraya, *Cur. Sc.*, **1**, 120, 1932). The magnetic moment of a neutron being nearly equal to that of a proton, the hyperfine splitting will be of the right order of magnitude as compared with the multiplet splitting due to the magnetic moment of the spinning electron. This approximate equality of the magnetic moments of a neutron and a proton follows directly from the measurements of Granath (*P.R.*, **42**, 44, 1932) on lithium. The magnetic effect of the spin of a free proton in the nucleus will be masked by the magnetic effect of its motion in just the same way as for the electron, but for a neutron the conditions may be different. In the case of a neutron its magnetic moment is perhaps due only to its intrinsic spin moment, because the orbital magnetic moment may be negligible owing to the fact that the neutron is a particle carrying no net charge. The resultant spin quantum number of the theoretical normal term of the neutrons arranged just like the extra-nuclear electrons is here coupled with the proton spin for obtaining the nuclear spin moment. Since the nucleus of cæsium may be considered to be made up of 27 α-particles, 24 neutrons and 1 proton, the arrangement in shells of the 24 neutrons on the electronic model would give a normal term $3d^5 4s^1\ ^7S_3$ corresponding to a spin value of 3. Combining this vectorially with a proton spin of $\frac{1}{2}$, the minimum energy configuration would give a spin moment of $\frac{5}{2}$ for the nucleus of the cæsium atom. This theoretical result is in conformity with our experimental value.

The Vertebral Column of Some South Indian Frogs.

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DR. H. K. MOOKERJEE has recorded in a note published in *Current Science* (Vol. I, No. 6, 1932), a case of *Rhacophorus maximus* in which the 8th. and 9th. vertebræ are procœlous, a condition which marks a departure from the well-known amphicœlous nature of the 8th. and 9th. having a boss in front and two behind such as occur in *Rana* generally. If it could be shown that the vertebræ are uniformly procœlous in this genus *Rhacophorus*, then its inclusion under the family Ranidæ, becomes a questionable procedure, since Nicholls has pointed out that the procœlous nature of the 8th. vertebra of *Bufo* may be used for diagnostic purposes. In view of the importance of the subject in its bearing on taxonomy I have examined the vertebral column of the following species:

Rhacophorus maculatus; Rh. eques; Rh. dubius; Rh. microtympanum; Ixalus chalazodes; I. sylvaticus; I. nasutus; I. oxyrhynchus; I. sp. (marked B in the museum collection); Micrixalus saxicola; Micrixalus sp. (marked A in the museum collection); Nyctibatrachus major; N. pygmœus; N. sanctipalustris; Nannobatrachus kempholensis (n. sp. Rao); Rana beddomii; R. bhagmandalensis; R. breviceps; R. brevipalmata; R. crassa; R. cyanophlyctis; R. curtipes; R. diplostichus; R. gracilis; R. intermedius; R. leithi; R. leptodactyla; R. limnocharis; R. malabarica; R. pantherina; R. parambiculamana (n. sp. Rao); R. sauriceps (n. sp. Rao); R. semipalmata; R. tennuilingua (n. sp. Rao).

Of the four species of Rhacophorus examined by me, I notice that the centrum of the 8th. vertebra is a variable structure. It is procœlous only in certain species such as *Rhacophorus maximus* (as reported by Mookerjee), *Rhacophorus dubius*, and *Rhacophorus microtympanum*, while it is amphicœlous in *Rhacophorus maculatus* and *Rhacophorus eques*. Possibly an examination of other species of this genus may reveal a similar divergence and if it be so, then we have clearly included in this genus *Rhacophorus*, two groups which, so far as the character of the 8th. and 9th. vertebræ is

concerned, will have to be dissociated. Whatever may be the nature of these vertebræ the transverse process of the 9th. vertebra is typically Ranid in the forms examined by me, and this fact should not be lost sight of in the investigation of the other species of *Rhacophorus*.

Prof. C. R. Narayan Rao informs me that the separation of *Micrixalus* from *Ixalus* is based on arbitrary grounds and possibly when a large number of species is examined, the diagnostic characters of the two genera may be found to be too slender for erecting two genera for their reception. Dealing, however, with the 8th. and 9th. vertebræ of these genera, I find that the former is procœlous in *Ixalus nasutus* (see Fig. 1),

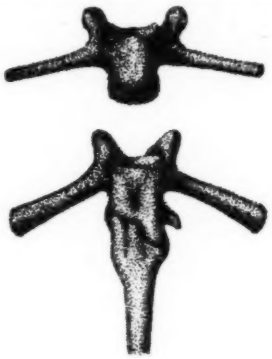

Fig. 1.

The procœlous 8th. and the fused 9th. and 10th. vertebræ of *Ixalus nasutus*.

Note the transverse process of the 10th. persisting on the left side and it has disappeared from the right. Additional proof is afforded of the fusion by the normal attachment of the urostyle on the right, while it is attached to the 10th. on the left side.

Ixalus chalazodes, *Ixalus sylvaticus* and *Ixalus oxyrhynchus*, while in species marked B in our museum collection it is definitely amphicœlous. In *Micrixalus* it is procœlous. There is divergence therefore in the character of the 8th. vertebra of *Ixalus*, some conforming to the Ranid group, others to the *Rhacophorus maximus* group, while *Micrixalus* is Ranid in every respect.

All the three species of *Nyctibatrachus* conform to the Ranid group in regard to the 8th. and 9th. vertebræ, while *Nonnobatrachus* bears procœlous 8th. and 9th. vertebræ.

Of the species of Rana only *Rana curtipes* and *Rana tennuilingua* call for special and critical observations, the others conforming to the normal feature.

Rana curtipes is indigenous to South India and is known for the large size of the tadpoles. A large number of these frogs were examined and the skeletons of adults were made for a comparative study.

In all the forms it is noticed that the 8th. and 9th. vertebræ are fused together to form a synsacrum. Dorsally the synsacrum carries a single moderately long neural spine. The zygapophyses are only two pairs and are borne on the anterior part of the fused 8th. and 9th. vertebræ (see Fig. 2). The transverse process in the region of the 8th. vertebra is similar to what is seen in the Ranid

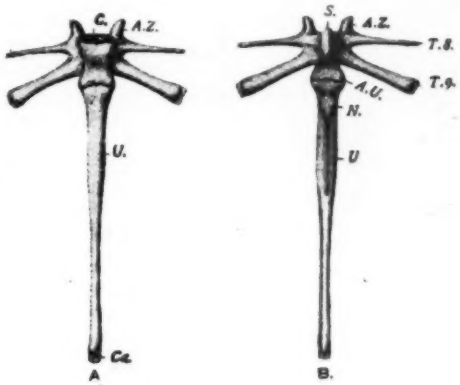

Fig. 2.

The fused 8th. and 9th. vertebræ and the Urostyle of normal *Rana curtipes*.

A. Ventral View. B. Dorsal View.

A.U. Articulation of the last vertebra with the urostyle; *A.Z.* Anterior zygapophysis; *C.* Procœlous centrum; *Ca.* Cartilage; *N.* Bony nodule on the urostyle; *S.* Neural spine; *T.8.* Transverse process of the 8th. vertebra; *T.9.* Transverse process of the 9th. vertebra; *U.* Urostyle.

examples. The transverse process in the region of the 9th. vertebra is large and expanded and bears epiphysis for the attachment of the ilium. The urostyle which is long, leaves a gap dorsally between the last vertebra and the commencement of the urostyle and at this point it bears a round bony nodule. At the terminal part, it is cartilaginous and in one case slightly anterior to the terminus, it shows an apparently segmented nature. In the same example of *Rana curtipes* (see Fig. 3) on the right side of the animal the transverse

process in the region of the 8th. vertebra expands itself and gives attachment to the ilium, while on the left side of the animal

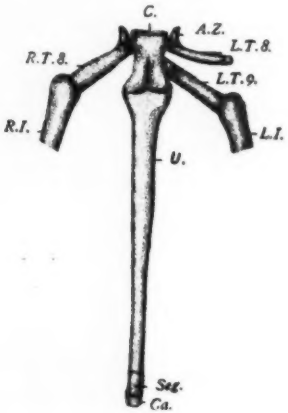

Fig. 3.

The fused 8th. and 9th. vertebræ and the Urostyle of *Rana curtipes*. Ventral View.

A.Z. Anterior zygapophysis; *C.* Procœlous centrum; *Ca.* Cartilage; *L.I.* Left Ilium; *L.T.* 8. Left transverse process of the 8th. vertebra; *L.T.* 9. Left transverse process of the 9th. vertebra; *R.I.* Right Ilium; *R.T.* 8. Right transverse process of the 8th. vertebra; *Seg.* Apparent segmentation; *U.* Urostyle.

there is a slender transverse process similar to what is seen in other examples of *Rana curtipes*. Further on the left side there is a typical transverse process belonging to the region of the 9th. vertebra (which is, however, absent from the right side) and this gives attachment to the ilium on this side.

One more variation is noticed; the transverse processes of the 3rd. vertebra bear an anteriorly directed bony process, a feature common in *R. tigrina*.

We may sum up the observations as follows: The possession of eight vertebræ (the fused 8th. and 9th. representing only one); the disappearance of the transverse process of the 9th. in one example on the right side and the shifting forward of the iliosacral attachment on this side by one segment, and the long urostyle possessing a bony nodule dorsally, are all points of great morphological interest. We may now discuss their significance.

In order to estimate the importance of the variation noticed in *Rana curtipes*, we have to recall the condition in *Pelobates*, *Pipa* and *Hymenochirus*. In these examples and in *Bombinator* the urostyle is fused with the last sacral vertebræ. *Pelobates* represents the oldest morphological condition in having 10th. and 9th. as the sacrum: in *Rana* and other forms the iliosacral articulation has been carried forward to the 9th., and in Pipa, the 9th. and 8th. participate in the attachment, their transverse processes fusing to form a broad winglike expansion to provide articulation with the ilia. Now, in the case of *Rana curtipes*, the centra of the 8th. and 9th. have fused, but their diapophyses remain discrete, those of the 9th giving attachment to ilia usually. In one case, the ilium on the right side of the animal is attached to the transverse process of the 8th.; the transverse process of the 9th. on this has atrophied, while on the left side the attachment is as in other cases of *Rana curtipes*. In the fossil forms of *Palæobatrachus* the 7th. is in a transitional state; while in *Hymenochirus* the first sacral vertebra is 6th. and those behind being added to the urostyle. The shifting forward of iliac attachment in these examples has been used to explain how the wide gap that separates the Urodeles from Anura in regard to the number of presacral vertebræ, can be bridged over. The position of *Rana curtipes* in the series is obviously one older than that of Pipa. In the former the centra of the 9th. and 8th. vertebræ have fused, but not their transverse process, which have also fused in the latter. In the example of *Rana curtipes* in which the lopsided variation has been noticed, we have a condition perhaps more recent, the 9th. having lost the transverse process on the right side. Thus Pipa stands between the normal *Rana curtipes* and the variant of this species.

In the next example,—*Rana tennuilingua* there are 9 vertebræ. The 7th. is amphicœlous, the 8th. opisthocœlous and the 9th. is typically Ranid. This is possibly an erratic variation since other examples of the same species do not show this phenomenon. As far as is known to me this is the first case to be recorded of the occurrence of the opisthocœlous nature of the vertebra among fermisternia, while a large number of cases could be cited among the arcifera. Judging by the inconstancy and the arbitrary nature of the centra in these forms, I think that the character of such variable structures as the vertebra may

not prove a very useful criterion in the classification of these forms.

In view of the extremely variable character of the 8th. and 9th. vertebræ in the Ranidæ, the generalisation of Boulenger that in those forms where the vertebræ are procœlous the 8th. is biconcave, seems to call for slight amendment, so as to permit the inclusion in it of the variation even within the limits of a genus. Obviously, these variations at least in the examples examined by me would appear to be fortuitous and can have no genetic significance.

In a further communication, I hope to be able to record the evidence derived from a study of the tadpoles of *Rana curtipes* bearing on the peculiarities of the vertebræ of this species noted in the present paper.

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Gadow, "Amphibia and Reptiles," *Camb. Nat. Hist.*, 1923.
Boulenger, *Tailless Batrachia of Europe*, 1897.
Ecker, *Frog*, 1889.
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Cunningham, *Reptiles, Amphibia and Fishes*, 1912.
Raichoudhury and Das, "Malformations in Bufo," *Anat. Anz.*, 1934.

Letters to the Editor.

The Wavestatistical Theory of Spinning Electron.

THE quantum mechanical theories of the spinning electron have been given by Dirac, Darwin and Pauli. Except that of the last one which is simple but not rigorous, the theories are based on non-commutative laws justifying the breaking up of a second order differential equation into the linear form. But in that case the dynamical aspect of the problem undoubtedly falls to the background. This point has been criticised at length in a recent paper of ours. (*Ind. Phys. Math. Jour.*, **3**, 65, 1932.)

We are now in a position to announce that even without introducing the idea of non-commutative association and consequent splitting of the second order differential equation, it is possible to derive Sommerfeld's correct expression for fine-structure. It may be briefly explained below:—

The well-known R-equation for the x_1 and x_2 waves in the $\{\mu\}$-space (for elliptic orbit) is:

$$\frac{d^2R}{d\gamma^2}+\frac{2}{\gamma}\cdot\frac{dR}{d\gamma}+\left(A+\frac{2B}{\gamma}+\frac{C}{\gamma^2}\right)R=0$$

where $C=l\,(l+1)$, l having the values 0, 1, 2,....etc. It is well known that in case of electron-spin, the orbital moment always determines the sign of the total moment. Thus when $J=l+\frac{1}{2}$, l can have minimum value 0, but for $J=l-\frac{1}{2}$, l has the minimum value one. The dynamical basis of this may be seen without difficulty.

Now, as in the above R-equation $l_{min}=0$, it may be used only for the +vely spinning electron. But for the −vely spinning electron C must be changed to $(l-1)\,l$; so that $l_{min}=1$. Thus we have different R-equations for the +vely and the −vely spinning electron, which give in the usual way:

$$\frac{B}{\sqrt{-A}}=n\psi+l+1, \quad \text{for +ve spin}$$

$$\frac{B}{\sqrt{-A}}=n\psi+L, \quad \text{for −ve spin}$$

Remembering the difference in the minimum values of l, we find that the Eigen-value of energy given by both is the same.

In the case of relativistic Kepler orbit the R-equation is unaltered in form but the constants A, B, C have the values (*vide* Sommerfeld-Erganzungsband)

$$A=\frac{4\pi^2}{h^2c^2}\,(E^2-E_0^2),\quad B=\frac{4\pi^2}{h^2c^2}\,zc^2E \quad \text{and}$$

$$C=-l\,(l+1)+\alpha^2z^2$$

As already pointed out C can have the above value for positive spin only. For negative spin

$$C=-l\,(l-1)+\alpha^2z^2$$

It may be seen by following the usual method that neither of the two R-equations (with the two above values of C) give the correct Eigen-value of energy. This we find to be due to neglecting the effect of spin on the velocity of the x_1 and x_2 waves. It may be easily evaluated from the well-known Thomas effect (*Phil. Mag.*, **3**, 1, 1927) and is found to be of the same order as the relativity effect. We find that the values of A and B are unchanged but C has the value

$$C=-l\,(l+1)+\alpha^2z^2-\frac{\alpha^2z^2}{2\,(l+1)}, \quad \text{for + spin}$$

$$C=-l\,(l-1)+\alpha^2z^2-\frac{\alpha^2z^2}{2l}, \quad \text{for − spin}$$

Using these two corrected values of C in the R-equation we get

$$W = -\frac{Rhz^2}{n^2}\left\{1+\frac{\alpha^2 z^2}{n^2}\left(\frac{n}{l+1}-\frac{3}{4}\right)\right\}, \text{ for } + \text{ spin}$$

$$= -\frac{Rhz^2}{n^2}\left\{1+\frac{\alpha^2 z^2}{n^2}\left(\frac{n}{l}-\frac{3}{4}\right)\right\}, \text{ for } - \text{ spin}$$

which are the well-known spin-relativity Eigen-values of energy.

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Polyembryony in Solanaceæ.

HABERLANDT[1] has observed parthenogenetic development of the endosperm, and early stages in the development of adventitious embryos in *Scopolia*, grown under unfavourable conditions. Biraghi[2] also observed the formation of adventitious embryos in *Nicotiana rustica* var. *Brasilia*, when pollinated with *Petunia* pollen. Young[3] found the presence of more than one embryo-sac in the same ovule of *Solanum tuberosum*. He believes that only one embryo-sac matures while the other degenerates. In the course of our investigation on the embryology of Solanaceæ, evidence of polyembryony has been obtained in different genera grown under natural conditions. In *Nicotiana plumbaginifolia* two well-developed embryos have been found in two separate embryo-sacs in the same ovule (Fig. 1). Two fully mature embryo-sacs in the same ovule have also been observed in *Withania somnifera* (Fig. 2), and in *Physalis minima*. Earlier stages in the development of adventitous

Fig. 1.

Nicotiana plumbaginifolia; two developed embryos in the same ovule.

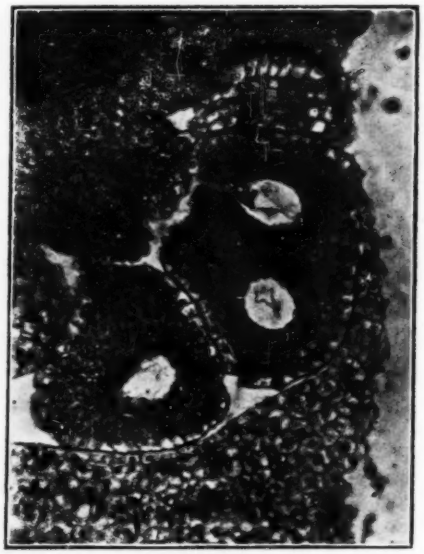

Fig. 2.

Withania somnifera; two mature embryo-sacs in the same ovule.

embryos by the budding of the nucellar cells covering the embryo-sac have been observed in *Petunia nyctaginiflora* and in *Withania somnifera*. It follows, therefore, that polyembryony is not uncommon in Solanaceæ. The development of more than one embryo-sac in the same ovule is generally due to the simultaneous development of more than one megaspore mother cell, which appears to be a common feature in most of the species of Solanaceæ. A detailed study of

[1] Haberlandt, "Schnarf", *Vergleichende Embryologie der Angiospermen*, p. 177, 1931.

[2] Biraghi, *Annali di Bot.*, **18**, 216, 1929.

[3] Young, *Amer. Jour. Bot.*, **9**, 213, 1922.

the embryogeny of Solanaceæ has been made by the junior author and will shortly appear elsewhere.

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The Germ Cells of *Ichthyophis glutinosus*.

PROBABLY due to difficulty in getting adequate material, our knowledge about the germ cells in Gymnophiona, their origin and the general problem of gametogenesis in this group remains very meagre as compared with the work on other amphibians. Apart from the works of Spengel[1] and the Sarasins[2] no reference to any recent literature is available. Even these authors confine themselves to certain aspects of the urino-genital system of Gymnophiona. The Sarasins have described the mature spermatozoan and admit to their not having studied its development.

The testes in Ichthyophis are segmented and extend over nearly two-thirds of the length of the body. One fact of importance is the indefiniteness in the number of these

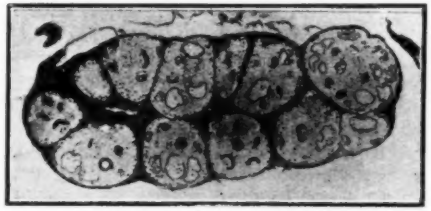

Fig. 1.

Longitudinal section of a testis-lobe of Ichthyophis.

testis-lobes, which may vary in different animals and even on the two sides of the same individual. The latter feature may perhaps be explained as due to the asymmetry of organs on the two sides consequent on the burrowing and coiling habit of these animals. So far as I am aware, the number of the testis-lobes may vary between six and fifteen on each side. Nor is there any relation between the number of the testis-lobes and the age of the animal. For, I have found in young forms (where still the gill clefts are not closed) the number of the testis-lobes larger than in some adults. The size of the lobes also is subject to great variation. Sometimes a lobe may measure over 5 mm. in length in certain regions while in others, it may be smaller than a millimetre.

The anatomy of the testis and its relation with the excretory system have been studied by Brauer.[3] An external examination of the testis-lobe reveals its deeply lobulated nature, marked on the surface by convex rounded elevations. In Urodeles (Humphrey,[4] Kingsbury[5]) the testis is an elongated cylindrical organ traversed by a longitudinal central collecting duct around which the lobules are arranged radially. It is also well known that in each locule, the cells develop synchronously. In some forms (Kingsbury,[5] Humphrey[6]) a postero-anterior development of the germ cells (Spermatogenetic wave) has resulted in the formation of a multiple testis, which, however, is different from that in Ichthyophis. In this form, the longitudinal collecting tube is by no means so regularly central as in Urodela and the locules are arranged in a more irregular fashion. Another thing of importance is the absence of this synchronous development of the germ cells in the locules. The locules are very large and filled with loose fibrous tissue in which are embedded the germ cell cysts without any definite walls of their own. A large number of such cysts can be distinguished in each locule representing every stage in spermatogenesis, from the spermatogonia to the fully formed sperms.

The testis is covered by a germinal epithelium which is continuous with the peritoneum of the coelom. It is usually thin consisting of a single layer of columnar or cubical cells but at some places thickens to form aggregations of very deeply staining cells. An examination of the sections of the testis shows that these aggregations occupy the interstices of the locules also, investing

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[1] Spengel, J. W., 1876. *Arb. aus dem Zool. Zootom*, 3, S. 1–114.

[2] Sarasin, P. & F., 1890. *Ergeb. Natur. Furchungen auf Ceylon*, 2, S. 1–263.

[3] Brauer, 1902. *Zool. Jahrb. (Anat.)*, XVI.

[4] Humphrey, R. R., 1925. *Biol. Bull.*, Vol. XLVIII, No. 3, pp. 145–166.

[5] Kingsbury, B. F., 1902. *Am. Journ. Anat.*, Vol. I.

[6] Humphrey, R. R., 1922. *Biol. Bull.*, Vol. XLIII.

the collecting ducts. Hargitt[7] has shown that in Diemyctylus, the lining of the ducts gives rise to the germinal epithelium from which fresh spermatogonia arise in the adult. He figures the terminal branches of the ducts

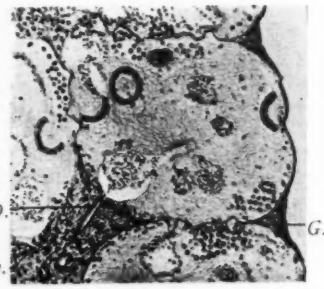

Fig. 2.

A part of the longitudinal section of a testis-lobe of Ichthyophis showing one of the loculea emptying its contents into a duct. The darkly staining cell aggregations represent the source of the germ cells in the adult.

D.—Duct. *G.C.ag.*—Germ cell aggregations.

ending blindly in masses of germ cells. In Amphiuma, MacGregor[8] finds the central duct of the testis capable of sending spermatogonia into the locules which are arranged in a radial manner around it. In Ichthyophis, it is not only the terminal branches of the ducts that give rise to the germ cells, but throughout its extent in the testis, the duct system is capable of developing germ cells from its lining. The similarity of the cells in the germinal epithelium on the surface of the testis and in these internal aggregations is very striking and there are reasons to believe that in both cases these cells first migrate into the locule and are later transformed into spermatogonia. Occasionally, however, mitoses may occur in these germinal cells.

A study of the spermatogenesis of this animal is in progress and the results will be published elsewhere.

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March 16, 1933.

[7] Hargitt, G. T., 1924. *Journ. Morph.*, Vol. XXXIX, No. 1.

[8] MacGregor, H., 1895. *Journ. Morph.*, Vol. XV, Suppl.

Spectrum of Bi III.

THE spectrum of Bi III has been analysed by Lang[1] and Mclennan[2], Mclay and Crawford. The classification of the higher transitions is identical in the two cases but of the fundamental transitions it is different. Mclennan, however, did not find $6p\ ^2P_1$, the deepest term of the spectrum. Of the multiplet $6p\ ^2P - 6d\ ^2D$ of Lang the line 75924(30) belongs to Bi IV as shown by Arvidsson[3] and 74065(15) has not been obtained by Arvidsson nor is it present in the work of Lang.[4] Line 70257(10) of $6p\ ^2P - 7s\ ^2S$ fits well from considerations of intensity and position in the spectrum of Bi II[2] as $6p^2\ ^1D_2 - 6p\ 6d\ ^1F_3$, 87169(4) taken from Arvidsson's list, being $6p^2\ ^3P_2 - 6p\ 6d\ ^1F_3$. 101023(12) in $6p\ ^2P - b\ ^2S$ belongs to Bi IV[3]. The intensities of the pair $6p\ ^2P_{1\text{-}2} - b\ ^2D_2$ are unexpected and the pair may be fortuitous.

Extrapolating from the spectrum of Tl I and Pb II the separation of $6p\ ^2P$ for Bi III should be about 20500. The following pairs with a frequency difference of 20790 have been obtained:—

95074(8) 96154(4) 108052(6) 108586(7) 130966(2)
74287(15) 75367(9) 87266(6) 87795(4) 110176(5)

In the first two pairs, the lines 74287 and 75367 have been already identified by the above authors as $6p\ ^2P_2 - 7s\ ^2S$ and $6p\ ^2P_2 - 6d\ ^2D_2$. 95074 and 96154 may be fixed as $6p_1\ ^2P_1 - 7s\ ^2S_1$ and $6p\ ^2P_1 - 6d\ ^1D_2$. The other pairs probably arise from $6p\ ^2P - 6s\ 6p^2\ ^{4,2}P, ^2D, ^2S$.

Due to some misprint the value of $6p\ ^2P_2$ in Mclennan's paper is given 184390, 1000 less than the actual value. Making the correction $6p\ ^2P_1$ is thus equal to 206180.

JAI KISHEN.

S. D. College, Lahore,
March 1933.

Measurement of Viscosity by Oscillating Columns.

THE method of oscillating columns was used for determining the viscosity co-efficients by Menneret[5] and Subrahmanyam[6], whose work both theoretical and experimental was

[1] Lang, *Phys. Rev.*, **32**, 737, 1928.

[2] Mclennan, Mclay and Crawford, *P.R.S.*, **129**, 579, 1930.

[3] Arvidsson, *Ann. Der. Physik*, **12**, 802, 1932.

[4] Lang, *Phil. Trans. Roy. Soc.*, **224**, 371, 1924.

[5] *J. Phys.*, **I**, 753, 1911.

[6] *Ind. Jour. Phys.*, **I**, 267, 1927.

found, on examination, incomplete and incapable of giving correct results. It can be shown mathematically that the logarithmic decrement for a liquid oscillating in a U tube to be $\frac{1}{2} \nu k^2 t$, where ν is the kinematic viscosity co-efficient and $k=1{\cdot}2197\ \pi/a$ where a is the radius of the tube. The oscillations can be photographed and the log. dec. measured. By applying the above formula values were obtained for ν, and they agree very well with the standard values given in International Critical tables. Full details of the work will appear elsewhere.

J. C. KAMESVARA RAV.
S. VENKATARAMAN.

Nizam College,
Hyderabad (Dn.),
March 25, 1933.

The Cathode Fall of Potential in Arcs.

LANGMUIR[1] has shown how it is possible to obtain a reliable estimate of the space potential and electron concentration by a study of the volt-ampere characteristics of a probe collector immersed in an ionised gas. This method has been employed by a number of experimenters to determine the cathode fall in arc discharges. Measurements have been made in the case of mercury by Lamar and Compton[2] and in the case of cadmium and thallium by Nottingham[3] and it was found by these observers that the cathode fall in each case was in the neighbourhood of the ionisation potential of the respective metals. Similar measurements have been made in a copper arc by Nottingham[4] and it is found that the cathode fall is 20·5 volts while the first ionisation potential of Cu is only 7·69 volts. It is interesting to note also that Anderson and Kretchman[5] who measured the cathode fall in a tungsten arc found it to be 16·2 volts, while the total potential across the arc itself was only 14 volts with a current strength of 12 amperes.

Measurements of a similar kind are comparatively difficult in the case of the sodium arc and the first attempt to determine the cathode fall in sodium was made by the present writer[6]. In the type of arc used by the author, the cathode was a pool of sodium with a device for restricting the movement of the cathode spot and the anode was an iron rod cooled by a stream of oil circulating through it. The cathode fall of potential was found to be 6·2 volts, the current strength in the experiments being 2 amperes. The cathode fall was found to rise up to 7·5 volts when a tungsten wire anode was used in place of the cooled iron anode. Recently F. H. Newman[7] describes a similar set of measurements he has carried out in a sodium arc carrying 5 amps. current and has found the cathode fall to lie close to 5 volts, the ionisation potential of sodium being 5·12 volts.

It is to be noted that the experimental results for the cathode fall in several metallic vapours as obtained by different observers do not show much agreement. For instance, in the case of mercury, Kömmnick and Lubcke[8] find the cathode fall lying between 9·0 and 11·3 volts in place of 10 volts as found by Lamar and Compton[9] and they point out that the cathode fall is influenced by pressure and density of the vapour. On the other hand, if the high field emission theory put forward by Langmuir[10] applies to the "cold cathode" discharge of the mercury arc type, the cathode fall for mercury shall have to exceed 13·4 volts as shown by R. C. Mason[11] from theoretical considerations based upon quantum mechanics. The discrepancy between the results obtained by the different observers and the discrepancy between the experimental and theoretical values in the case of mercury, indicate that the cathode fall is probably influenced to a marked extent by the conditions of the arc, such as current density and vapour pressure. Quite recently J. Kömmnick[12] finds that the cathode fall of potential in the mercury arc increases with decrease of the vapour pressure. This observation seems to account, therefore, for the difference in the value of 6·2 volts for the cathode fall in the sodium arc for a current strength of 2 amperes obtained by me and the value of 5 volts, corresponding to a current of 5 amperes

1 *Gen. Elect. Rev.*, 440, 1924.
2 *Phy. Rev.*, **37**, 1069, 1931.
3 *Jour. Frank. Inst.*, **206**, 43, 1928.
4 *Jour. Frank. Inst.*, **207**, 299, 1929.
5 *Phy. Rev.*, **26**, 23, 1929.
6 *Proc. Ind. Sci. Congress*, p. 106, 1932.
7 *Phil. Mag.*, **15**, 601, 1933.
8 *Phy. Zeit.*, **33**, 215, 1932.
9 *Loc. cit.*
10 *G. E. Rev.*, **26**, 731, 1923.
11 *Phy. Rev.*, **38**, 427, 1931.
12 *Ann. der. Physik.*, **153**, 273, 1932.

observed by Newman,[13] since the vapour pressure is directly influenced by current density. It is also interesting to note, according to the observations of F. H. Newman,[14] that the fall of potential across the sodium arc decreases from 16 volts to 10·5 volts for an increase of arc current from 3·2 to 6·8 volts.

As regards the reliability of the measurements by Langmuir's probe collector method, F. H. Mohler[15] records that the probe wire measurements in his investigation of probabilities of recombination in the $6^2S_{\frac{1}{2}}$ state of caesium gave correctly the electron velocity distribution. J. Johannesson[16] who has devised a new probe method finds good agreement for the values of space potential obtained by his and Langmuir's collector method in a discharge tube. It therefore looks that a more extensive set of data of the cathode fall as influenced by varying arc conditions are needed before Langmuir's high field emission theory can be considered conclusively to apply to cold cathode arc discharges.

C. K. SUNDARACHAR.

Central College,
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April 5, 1933.

Spectrum of doubly ionised Cerium.

THE spectrum of doubly ionised cerium between λλ 3600 to 2100 consists of triplets and singlets and is similar to singly ionised lanthanum in many respects. Practically all the lines which have so far been unambiguously identified as due to Ce^{++} are derived from transitions between the terms of the configurations 4f 5d, 4f 6s, 4f 6p, and 4f 6d. The strongest combinations are between 4f (6s—6p). Some of these terms are given below:—

4f 5d

1.	0	9.	5118·7
2.	797·9	10.	5372·1
3.	1648·0	11.	6327·9
4.	2334·6	12.	6998·2
5.	3823·4	13.	7139·0
6.	3982·9	14.	7678·4
7.	4397·9	15.	10134·8
8.	4624·2	16.	10649·4

4f 6s

1.	13732·6	3.	15973·0
2.	13968·8	4.	16345·9

4f 6p

1.	42763·8	7.	46137·1
2.	42901·6	8.	46678·2
3.	44554·6	9.	46937·6
4.	44871·7	10.	48112·5
5.	45758·6	11.	49045·9
6.	45786·1	12.	49053·0

Complete list of the classified lines along with the identifications of the terms will be published elsewhere.

PRAN NATH KALIA.

Department of Physics,
Government College,
Lahore,
February 12, 1933.

Viscosity of Liquids.

THE letter of Prof. Andrade in *Nature* (March 1 and April 12, 1930) on the variation of the viscosity of liquids with temperature on the conception of "a transitory and fluctuating crystallisation" occurring in the body of the liquid has created a good deal of interest in the subject, and the publication of his full theoretical discussion is eagerly awaited. Historically his formula connecting viscosity with temperature may be traced back to Porter's original relationship $\log \phi = m \log p + c$ (*Phil. Mag.*, **23**, page 458, 1912) where ϕ is inverse of η the viscosity, p is the vapour pressure and m and c are constants. This when combined with the Clausius-Clapeyron equation $\log p = -Q/RT + C$, where Q is the heat of evaporation and R and C are constants gives the formula $\log \eta = A + \frac{B}{T}$ which is the formula put forward by Andrade.

The same formula had also been put forward by Sir C. V. Raman in *Nature* (April 12 and May 5, 1923) on the assumption that the liquid state is composite in character, being composed in part of molecules rigidly attached to each other somewhat as in a crystal and may be termed "crystalline" molecules and in part of molecules which are relatively free and mobile as in the gaseous state and may be termed "vapour" molecules. Raman not only outlined there a physical mechanism of the phenomena of liquid-viscosity but pointed out also the theoretical significance of the constants occurring in the above formula.

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[13] *Loc. cit.*
[14] *Phil. Mag.*, **14**, 712, 1932.
[15] *B.S.J.*, **6**, 277, 1931.
[16] *Ann. der Phy.*, **13**, 953, 1932.

The formula seems to be of very wide application and has been tested in case of 87 liquids by M. P. Venkataram Iyer (*Indian Jour. of Physics*, **5**, p. 371, 1930) and also by B. Prasad (Unpublished work) who finds good agreement between the observed and the calculated values except in case of water and some higher alcohols. But all these are highly associated liquids for which Andrade has suggested the formula $\eta = \frac{B'}{A' e^{\frac{C}{T-\theta}}}$ and with this the agreement is quite satisfactory. The formula has also been tested in case of solutions and the results have been communicated elsewhere for publication. Attempts are also being made to extend the applicability of the formula to liquids of no definite chemical composition and mixtures.

It is interesting to note in this connection that in his letter to *Nature* (April 12, 1930) Black had pointed out that Andrade's formula does not hold so well in case of certain mineral oils as does the formula of Slotte. Andrade had disposed of Black's objection on the ground that the mineral oils were of no definite chemical composition. But, if instead of using Andrade's original formula for simple liquids we use the formula $\log \eta = A + \frac{B}{T-\theta}$ for associated liquids the agreement in case of Black's oils is found to be better than that with Slotte's formula, as will be seen from the table given below. The value of the constants used in the formula are as follows :—

$A = -3{\cdot}2878$, $B = 548{\cdot}78$, $\theta = 170{\cdot}22$

Temp. C.	η(obsd)	η_{cal}(Slotte)	η_{cal}(Mine)
20	15·20	15·46	15·21
25	10·15	10·19	10·17
30	7·04	6·99	7·01
35	4·97	4·93	4·95
40	3·58	3·58	3·59
45	2·67	2·66	2·67
50	2·00	2·01	2·01
55	1·55	1·558	1·55
60	1·232	1·217	1·217
65	0·965	0·966	0·963
70	0 780	0·777	0·775
75	0·633	0·636	0·630
80	0·517	0·522	0·518
85	0·432	0·435	0·432
90	0·362	0·363	0·362
95	0·306	0·305	0·306

In view of the agreement found in case of the mineral oils measurements are being undertaken with some vegetable oils, oil-mixtures and lubricants to find out how far the formula agrees in their case too.

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Magnetism.

UNDER the auspices of the Mathematics and Physics Section of the 20th Indian Science Congress, a Symposium on Magnetism was held during the Congress Week at Patna. DR. A. L. NARAYAN who presided, inaugurating the symposium, said : "The subject of to-day's discussion is one which is of great importance in modern physics and is now engaging the attention of quite a number of investigators. Recent years have witnessed an extensive development both in theory and experiment. The application of the new quantum mechanics has removed a number of difficulties that confronted the explanation of magnetic susceptibilities of the ions of the iron group. A large part of this success is due to Professor Van Vleck who has also recently published a standard work on the subject. It is fortunate that a discussion on this interesting and important branch of Physics will be opened by Professor D. M. Bose whose own researches showed the direction in which lay the solution of the difficulties that beset an explanation of the paramagnetism of the rare earth ions. The work of Stoner and Van Vleck has proved the justice of the position taken by Professor Bose and given a theoretical basis for his views.

The study of the magnetic birefringence in liquids discovered by Cotton and Mouton has thrown much light on molecular anisotropy. Sir C. V. Raman, I. Ramakrishna Rao and K. S. Krishnan have carried out a number of important investigations in this field. Mr. Krishnan is now engaged at Dacca in new researches on magnecrystalline phenomena and we await with interest his exposition of the subject. At Calcutta Mr. Chinchelkar is continuing Ramakrishna Rao's researches on optical anisotropy and he will favour us with a resume of the work done in this field. I may mention some other Indian investigators who are working in this field : Dr. Vaidyanathan at Calcutta, Professor Bhatnagar at Lahore, Dr. S. Ramachandra Rao at Annamalainagar and Messrs. L. Sibaiya and H. S. Venkataramiah at Bangalore are engaged in the study of magnetic susceptibilities and have obtained interesting results. The work of Mr. S. Paramasivan on the difference in the susceptibilities of graphite in the solid and powdered states deserves mention in this connection.

Professor B. Venkatesachar is to speak on a subject which is as yet undeveloped, but promises to be of great interest, *viz.*, the magnetism of the

nucleus. Ever since Pauli showed that the hyperfine structure of spectral lines could be explained by assuming a mechanical and magnetic moment for the nucleus, and the classical work of Back and Goudsmidt completely vindicated this idea, a large number of workers have engaged themselves in the study of hyperfine structure and nuclear moments. Work in this field is being carried out by me and my collaborators at Kodaikanal and some of our results have already been published. The results recently obtained by A. S. Rao in his investigation of the H.F.S. of Tl, As and Br deserve special mention. A theoretical explanation attempted by Goudsmidt, Cassimir, Fermi, Breit, Racah and others has only served to show the inadequacy of the theory, and among other anomalies, unexplained and faint, but real, satellites have been found by Professor Venkatesachar. One such anomaly is the erratic relations of the g(1) factors of the nuclei of different elements. Professor Venkatesachar here makes an interesting way of explaining this behaviour of atomic nuclei. He bases his contribution on the new possibilities opened up by the discovery of the neutron and the attempt of Heisenberg to explain the radioactive properties of nuclei by using the neutron hypothesis. It is a fascinating field although as yet isolated from the main current in the subject of magnetism. I now have much pleasure in calling upon Dr. Bose to open the discussion."

DR. D. M. BOSE opened the discussion with an account of the development of magnetic theory up to the present time. He referred to his own contribution to the subject and its bearing on its future history.

DR. K. S. KRISHNAN speaking on some magnocrystallic investigations said, "Measurements have been made in the author's laboratory on the magnetic anisotropies of a large number of crystals and the results are discussed in relation to crystal structure.

It is found that in the case of diamagnetic crystals, the crystalline anisotropy can be explained in terms of the intrinsic anisotropy of the individual molecules or ions constituting it, and their relative orientations in the crystal. Hence, when the molecular magnetic constants are known, a correlation of these constants with those of the crystal, gives us valuable information regarding the orientations of the molecules in the crystal lattice. In favourable cases like biphenyl, dibenzyl, α- and β-naphthols, etc., it is found possible, in this manner, to locate the precise molecular orientations. In less favourable cases some of the angular parameters defining the molecular orientations can be so derived. Even in complicated cases like azobenzene and stilbene, where it is not possible to obtain a unique solution, the magnetic data throw considerable light on the question, which would help us at least to decide between alternative orientations suggested by X-ray methods. In any case it is clear that no structure proposed by X-ray methods can be considered acceptable that cannot satisfactorily explain the observed magnetic properties of the crystal. Thus the magnetic method of analysis of molecular orientations in crystals promises to be a useful supplement to X-ray methods of analysis.

Conversely, when the molecular orientations in the crystal lattice are already known from X-ray investigations, a knowledge of the principal magnetic susceptibilities of a diamagnetic crystal enables us to deduce the constants for the molecules. The values for naphthalene and anthracene molecules thus calculated are of interest; it is found that as we proceed from benzene to naphthalene and from naphthalene to anthracene, the numerical increase in susceptibility is practically confined to one direction, *viz.*, that which is normal to the plane of the benzene rings.

Similar measurements have been made on a number of paramagnetic crystals. (A special method is developed for the measurement of very feeble anisotropies of the order of one-hundredth of one per cent.) The results are discussed on the basis of the recent theories of magnetic anisotropy proposed by Bethe, Van Vleck and others. Also the results of earlier measurements are critically examined, especially those of Jackson on $CoSO_4.(NH_4)_2SO_4.6H_2O$ and on $MnSO_4.(NH_4)_2SO_4.6H_2O$, and the wide discrepancies between the results obtained by different observers are explained.

Some measurements on the influence of the state of aggregation of diamagnetic molecules on their susceptibility are also reported."

MR. S. W. CHINCHELKAR speaking next said: "The longitudinal Faraday rotation of plane of polarisation has been known to be of two types, diamagnetic and paramagnetic. The researches in the paramagnetic type were mainly due to Beegusel and others, and its chief features are certain dissymmetries and under certain circumstances a negative sign. Ladenburg gave a theory of the paramagnetic Faraday effect and attributes it to paramagnetic orientation in a magnetic field. The transversal phenomenon of magnetic double refraction discovered by Cotton and Mouton in pure substances, was however, until recently, known to be exhibited by diamagnetic substances only. It is explained by Langvin's theory according to which the molecules of the fluid showing the effect tend to orientate when kept in a magnetic field on account of their magnetic anisotropy, and this tendency gives the medium a doubly refracting property due to the optical anisotropy of the molecules. A search made to find a corresponding phenomenon for paramagnetic substances has recently proved a success, and it has been shown at Calcutta that the aqueous solutions of salts of rare earths, which are paramagnetic, exhibit a magnetic birefringence. These solutions also show the paramagnetic Faraday effect, and a parallelism between the two phenomena in these solutions suggests that this new type of magnetic birefringence is an orientation phenomenon, although it is not clear whether Langvin's theory as it stands would be applicable here. The birefringence does not appear to show a simple relation with the magnetic moment of the ions. Gadolinium salts, though strongly paramagnetic, do not exhibit a magnetic birefringence in solution. The gadolinium ions are in the S state, having the whole of their paramagnetic due to spin, without any orbital contribution; and this shows that an orbital contribution to the magnetic moment is essential for the birefringence to be shown. Observations on the values of magnetic birefringence that have appeared recently, show very interesting regularities as we pass along the rare earth series. It is known that the series can be divided into two parts, one before and the other after gadolinium, corresponding to the erect and

inverted multiplets, and in each half the orbital contribution undergoes a similar variation. The magnetic birefringence is seen to be negative at the beginning of each half, then diminishes in magnitude and at the end of each half assumes a positive sign. The whole phenomenon is not yet quite clear, but promises to be of great interest and significance, and further experimental data are necessary."

PROF. B. VENKATESACHAR then spoke on 'The Magnetic Moment of the Nucleus.'*

In the discussion that followed, Dr. I. Ramakrishna Rao spoke as follows: "The small but finite optical anisotropy of the aliphatic compounds as revealed by the depolarisation of light scattered by them has led Prof. Raman and myself to examine if these molecules do not possess a corresponding magnetic anisotropy. Cotton and Mouton who discovered magnetic birefringence in the aromatic compounds, could not detect it in most of the aliphatics, which led them to conclude that the molecules of the latter class are magnetically isotropic. Thinking that this may be due to the feebleness of the phenomenon, we constructed a specially powerful electro-magnet. With the column of liquid perpendicular to the magnetic field, we found that there was a distinct double-refraction revealed by many of the aliphatic liquids when the magnetic field was on. There were two difficulties in the investigation of the phenomenon. The first was the elimination of the superimposed Faraday Effect which was accomplished after making the column of liquid exactly perpendicular to the magnetic field. The second was the measurement of the feeble double-refraction. While devising sensitive methods of measuring it, I had to leave Calcutta and Messrs. Ramanatham and Chinchelkar who continued the work and made quantitative estimates of the phenomenon ought to be congratulated upon the important work they did in this direction, thus making a distinct contribution to our knowledge of the magnetic anisotropy of the aliphatic molecules."

MR. L. SIBAIYA said: "The theories of diamagnetism developed by Van Vleck, Pauling and Hartree on the basis of the new quantum mechanics apply only to centro-symmetrical systems whose constituent particles can be regarded as independent. For such systems only, as Stoner points out, the diamagnetic susceptibility should not alter with temperature, since under those conditions the value depends on the configuration of the systems and not on their interaction. Even for Cl however the calculated susceptibility according to Hartree or Pauling is much too large. Experiments have shown that the diamagnetic susceptibility shows in some cases considerable variation with temperature, pointing to the conclusion that thermal agitation and molecular interaction play no negligible role. The variation in the case of water, for instance, is due to the increasing thermal agitation and to the progressive dissociation of such molecules as $(H_2O)_n$ at higher temperatures. Wills and Bocker, however, have very recently reported an anomalous behaviour for water.

Besides, from Pascal's measurements, the gram-molecular susceptibility of liquid benzene is -56×10^{-6} while from the results of Sone, Wills and Hector, and Vaidyanathan the susceptibility of benzene vapour is—83×10^{-6}. Though these data require further support, the diminution of mutual molecular influence in the vapour state has to account for the increased diamagnetism of benzene vapour. According to the orbital electron theory the mutual induction effect of the component systems must be more pronounced in the liquid state. Oxley also finds that there is a decrease of susceptibility of about 5% on passing from the liquid to the solid state. Thus it seems that the diamagnetic susceptibility decreases from vapour to liquid and further from liquid to solid states. This must correspond to the effect of reducing the temperature. To explain his observations Oxley assumed a molecular magnetic field of several million gauss which accounted also for the tensile strength of solids and the density change on solidification. On the other hand the diamagnetism of gallium, indium, thallium and bismuth decreases with increasing temperature. Again even a metal cannot be regarded as an aggregate of atoms with characteristics similar to those which they have in the free state. For instance the paramagnetic atoms, such as those of copper and silver, may form a diamagnetic solid. And the diamagnetism due to free electrons may be of the same order as that due to orbital electrons in metals.

Lastly, along with this dependence of susceptibility on the state of aggregation of the molecules, the mutual influence seems to be related also to the number of molecules at least upto a limit. The variation of susceptibilities of para- and diamagnetic colloids in relation to the particle size shown by Ramachandra Rao and by Montgomery supports this view. The intensities of magnetisation of colloid powders of nickel have been pointed out to be less than that of pure nickel; and the investigation with bismuth colloids has shown that the intensity of magnetisation decreases with particle size.

Thus the effects of temperature, state of aggregation and particle size on the susceptibility value should be first experimentally studied before a satisfactory theory of diamagnetism can be put forward.

* Prof. Venkatesachar's contribution has already appeared in these columns (*Cur. Sc.*, **1**, 8, 1933).

The Malers and the Malpaharias of the Rajmahal Hills.

By Sasanka Sarkar, M.Sc., *Anthropological Laboratory, Indian Museum, Calcutta.*

THE Mâlers of the Rajmahal Hills occupy the north-eastern portion of the district of the Santal Perganas. They live on the slopes of the hills and are still in a very primitive condition. The Mâlpâhâriâs, who belong to the same ethnic stock but live on the plain lands, are at present much Hinduised as a result of their intercourse with the neighbouring people. They occupy the southern portion of the Santal Perganas. In the course of my investigations among these tribes I discovered that the place (Pakur-Godda area) where these two cultures meet shows a curious intermixture of manners and customs.

The Mâlers have no clans, no exogamous divisions. Marriage is controlled by kinship and there cannot be any marriage with anybody falling within the kindred groups. These people can trace their blood groups, however, only up to the third generation. In collecting genealogies I often failed to secure the name of the informant's own grandfather, and among the Mâlpâhâriâs in more than one instance I failed to secure their father's name even. Both the Mâlers and the Mâlpâhâriâs have got a small patrilineal family which usually consist of their wives and children and in recent years a few joint families have sprung up among the latter, after the Hindus. The Mâlpâhâriâs, also, have adopted the clan system, although this is not universal among all the Mâlpâhâriâs. The clan system is not met with among the Mâlpâhâriâs of the Pakur-Godda area, where they are living as close neighbours of the Mâlers. Here, I also discovered a few instances of intermarriages between the two groups. The Mâlpâhâriâs of Dumka only present the clan system and these have been taken mostly from the Hindu titles of castes. A few words also have been taken from the Mâler language—the Mâlto. The Mâlpâhâriâs are at present classed within the Bengali-speaking people. The following are the names of the eleven clans of the Mâlpâhâriâs that I was able to collect:—(1) Singh, (2) Kumâr, (3) Ârhi, (4) Derhi, (5) Grihi, (6) Mânjhi, (7) Pujhor, (8) Rai, (9) Ghuns, (10) Pâtor, (11) Daloi.

The Derhi and Pujhor function as priests; the Derhi functions in the aboriginal worships while the Pujhor in the Hindu ones. The occupational basis is practically non-existent but in one of the genealogies that I collected I found a man describing himself as belonging to three clans. His father was a Singh, so he is a Singh; he is a Derhi and a Pujhor because he worships both the tribal and the Hindu deities.

Marriage among the Mâlpâhâriâs is permitted both inside and outside the above clans. Their clans very rarely play an important part in the choice of mates although I have always found them cognisant of the exogamy of the Santal and Hindu clans. As among the Mâlers, the Mâlpâhâriâs control their marriage according to the prohibited degrees of relationship.[1] The prohibited relations include the paternal uncle, maternal uncle, paternal aunt and maternal aunt and their children.

A study of the kinship system of the two tribes reveals some features of dual organization. The classificatory system is fairly widespread. There is a great deal of difference in the kinship terms of the two people—the Mâlers retain Mâlto words, whereas the other has Bengali terms, but there are traits of similarity in the kinship system as a whole among both. Evidence for dual organization may be seen in the use of the same terms for father's elder brother and mother's elder sister's husband (Pipo) and their wives (Peni); and father's younger brother and mother's younger sister's husband (Dâdâ) and their wives (Kâle) among the Mâlers. Among the Mâlpâhâriâs we find it true of only the above first pair of relatives although the terms Jethâ (father's elder brother) and Jethi (father's elder brother's wife) are both borrowed from Bengali; the father's younger brother and his wife are called Kâkâ and Kâki, respectively, and the mother's younger sister and her husband Moshi and Moshâ, respectively. The differentiation between the elder and younger brother of sister of either parents seems to be a recent one among the Mâlers, probably due to their contact with the Bengalis. It appears that the Mâlers and and the Mâlpâhâriâs belong to the same race and culture although at first sight they seem to be widely disconnected.

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[1] Risley, H. H., "The Tribes and Castes of Bengal," Calcutta, 1891, Vol. I, Introduction, p. xlix.

A Marine Biological Station for India.

THE desirability of establishing a Marine Biological Station in India was emphasised at a joint session of the Botany and Zoology sections of the Indian Science Congress recently held at Patna under the Presidentship of PROF. GOPALA AIYER. A large number of speakers took part in the discussion.

COL. SEWELL, in opening the discussion, referred to the great gap which would be filled by the establishment of such a station. Huge sums of money were spent annually on the expansion of agricultural schemes while the sea which provided sustenance to a considerable number of people in the country was yet left entirely untapped. He sounded a note of caution and observed that in setting up such a station, people ought not to be swayed by economic constitutions alone which were only secondary and subservient to the primary scientific and educational aspects of the project. The establishment of such a station at Karachi had been mooted in the past, but owing to financial stringency the scheme seemed to have been indefinitely shelved. Nor was there any prospect of the proposal being brought to fruition now in view of the embarrassing financial situation in India. He favoured the location of the station in Bombay on account of its central position, and also because Bombay's comparatively vast population would be able to make a fairly large financial contribution towards the establishment of this station.

DR. SETNA of Bombay strongly supported the idea of establishing the Marine Biological Station at Bombay. He mentioned that such stations existed in practically all the important countries of the West, and he felt that there was a great need for a station like this in India. He further observed that the teaching of biology in India was somewhat defective, as pickled materials rather than living animals were mostly used for the teaching purposes. Hence our graduates lacked a knowledge of the biology of living animals. He pointed out that Dr. Kemp had suggested the Andaman islands as a suitable site for establishing a Marine Biological Station, but Dr. Setna thought that such a station should be located in close proximity to the principal marine routes and also near big fish markets. Since Krusadi and Andaman islands were far out of the way, they were not suitable for this purpose. Bombay, on the other hand, was more centrally situated. This city was a centre of commercial life not only of India but also of Asia. A small admission fee to the station would be a source of revenue from the floating population of Bombay. He also thought that utilitarian motives should not be the primary consideration in this connection. Bombay possessed good spots where this station could be located. The actual site could be selected later on. Modest beginnings could be made with a few tables, but the whole scheme would cost 80,000 to a lakh of rupees. Money was therefore the main problem and owing to the present financial stringency not much support from the Government can be expected. Moreover, the development of agriculture in the country was occupying the entire attention of the Government for the present. He said that he had approached private individuals and prominent citizens of Bombay, who had promised to give financial support to this scheme. He suggested that the authorities of the Science Congress should sanction a certain sum of money which would act as a nucleus of public subscription. He thought that various universities in India would also contribute handsomely towards this project.

DR. B. K. DAS. The views of the previous speaker were to a large extent echoed by Dr. Das from Hyderabad-Deccan, who favoured Bombay as a site for the projected station. Dr. Das felt that Bombay was easily accessible to a large number of universities in the mofussil. He said that it was of vital importance that students of zoology should familiarise themselves with the habits of living marine organisms in the knowledge of which they reveal striking deficiencies at present. Habits of living aquatic forms which are not so well known at present should be studied. He observed that departments of fisheries should be run on scientific lines. Whatever collections of marine animals and plants are made, these specimens should be sold under the auspices of the Marine Biological Station.

DR. S. K. MUKERJI supported Dr. Setna's plea for locating the station in Bombay. As an ecologist, he said that Bombay was conspicuous in possessing varied types of environments such as rocky and sandy shores and therefore the sea round about Bombay should be rich in ecologically divergent marine types. He felt that the time for passing fervent resolutions on paper had gone and they should now seize the present opportunity of setting up a Marine Biological Station in Bombay with modest beginnings. A combined committee of botanists and zoologists should be appointed by this joint session to work out a practicable scheme and suggest means and ways of giving effect to this scheme. For this purpose, funds were urgently required, and he thought that it would not be difficult to raise money, as the committee would seek the co-operation of various universities in India and the moral and financial support of the local and central Governments. He urged the delegates to support the choice of Bombay for the establishment of this station.

DR. S. L. GHOSE fervently supported Dr. Mukerji's idea of forming a committee and suggested that this committee should also be entrusted with the task of selecting a site.

PROF. R. H. DASTUR said that a small beginning should be made. The committee should formulate the various problems which the station would tackle, but suggested that these problems should be placed before the public who will then be willing to give funds.

PROF. AWATI in advancing Bombay's scheme said it possessed various types of environments such as rocky and sandy shores.

Prof. Gopala Aiyer in winding up the discussion said that he had no objection to any particular place; Bombay or Madras would be equally good to him.

Dr. S. L. Ghose of Lahore then moved that a committee of five biologists be appointed by this joint session of Botany and Zoology sections of the

Indian Science Congress to go into the question of establishing a Marine Biological Station in India. Dr. B. K. Das of Hyderabad-Deccan seconded this resolution, which was carried by a large majority of members present.

The following five persons were elected as members to this committee:—

(1) Dr. S. B. Setna of Bombay, *Convener.*
(2) Prof. Gopala Aiyer of Madras.
(3) Prof. George Mathai of Lahore.
(4) Prof. R. H. Dastur of Bombay.
(5) Dr. S. K. Mukerji of Lucknow.

After a hearty vote of thanks to the chair the meeting came to a close.

Continental Movement.*

By W. D. West, Esq., *Geological Survey of India, Calcutta.*

INFLUENCED by the teaching of Sir Charles Lyell, geologists for many years held the view that the oceans and continents of the present day were not permanent features, but that at times in the past the oceans had been dry land and the continents submerged beneath the sea. But when it was found that true deep sea deposits did not occur far inland, geologists began to doubt the truth of Lyell's teaching, and instead the doctrine of the permanence of continents and oceans became widely accepted. Now once more opinions are divided, and views on the structure of the surface of the earth have of late undergone rapid changes.

In considering the probable distribution of land and sea in the past, the present-day distribution of plants and animals is very suggestive. For long scientists have tried to explain the similarity of the land and freshwater faunas on the opposite sides of the Atlantic ocean. Thus the common garden snail is confined to western Europe, Iceland, Greenland and eastern North America. The perch, a freshwater fish, and the earthworm, a land animal, have a somewhat similar distribution, which suggests that the north Atlantic ocean has not been a permanent feature, for the sea would seem to be an insurmountable barrier to the migration of these animals. Turning to the south Atlantic, the freshwater fishes again provide striking evidence. The fishes of South America are very varied, but they bear no relationship whatever to those of North America. This is easily understandable when it is realised that the narrow strip of land joining North and South America is a comparatively recent feature, and that these two countries were until quite recently separate land masses. But the remarkable fact is that the freshwater fishes of South America and Africa, now so far apart, are remarkably alike, suggesting, according to Tate Regan, that the two continents were connected in Cretaceous times.

One more comparison may be drawn, which demands an explanation, and that is between the birds and mammals of the southern continents of South America, South Africa and Australia. The struthious birds, the rhea, ostrich and emu, closely allied and of a peculiar type, are found only in those three countries respectively; while the marsupials are confined to South America and Australia.

It might be claimed that the principle of convergent evolution explains the appearance of similar types of animals in far separated parts of the world. But the evidence of parasitology makes this extremely improbable. Thus Von Ihering and others have shown that the marsupials of Australia and South America are infested by the same parasites in the rectum; and the parasites of the ostrich and the rhea are identically the same, although these two animals are now confined to Africa and South America, between which there is only deep sea. It is surely expecting too much of convergent evolution to explain by its means the development of both host and parasite on exactly the same lines in different places.

To account for the distribution of these animals, and for many others which cannot be mentioned here, the orthodox method has been to introduce so-called 'land bridges' connecting the various continents, which would provide a ready means for the migration of land and freshwater faunas. This necessitates that these land bridges have since sunk beneath the sea, and here at once we are up against a difficulty. For the sinking of large continental tracts is inconsistent with the theory of isostasy, which postulates that the continents, composed of comparatively light granitic rocks of specific gravity about 2·6, are floating in an underlying layer of basalt of specific

* The substance of a popular lecture delivered before the Indian Science Congress at Patna.

gravity about 2·9. The latter is of course solid, but can be regarded as being similar to pitch, possessing rigidity but very little strength, and capable of flowing slightly over a long period of time. The principle of isostasy is really nothing other than that of ordinary floatation, and its acceptance makes it difficult to understand how portions of the continental crust can possibly have sunk, since the underlying basalt is heavier than the light continental rocks. Hence if these land connections ever existed it is not easy to understand how they can ever have sunk.

This, then, was the position until a few years before the Great War, when an alternative explanation was put forward by the American geologist F. B. Taylor, which was subsequently amplified by the Austrian meteorologist Alfred Wegener, after whose name the hypothesis is usually known. This explanation was first suggested by the remarkable parallelism between the east and west coasts of the Atlantic ocean, for it led Taylor, and later Wegener, to suggest that America on the one hand and Europe and Africa on the other had once been united and had since drifted apart. It was at once seen that this theory provided an easy way of explaining the biological anomalies, and was also free from the objection associated with the land bridge hypothesis, for it was not inconsistent with the theory of isostasy. Wegener went further than Taylor, and brought Australia and India against South Africa. In this way an explanation was offered of the almost simultaneous appearance of glacial conditions in South America, South Africa, India, and Australia in Upper Carboniferous times, which was followed at once by the appearance of the peculiar glossopteris flora in each country after the ice had disappeared. For Wegener supposed that these countries were still joined together in Carboniferous times, with the south pole in their midst, and that they subsequently slowly drifted apart to their present positions.

To return once more to the Atlantic. For the hypothesis of continental drift to be true, not only must the shapes of the two coastlines fit fairly well, but also the grain, or geological structure, of the lands on either side must correspond. As regards the north Atlantic, the two old mountain systems of Europe known as the Caledonian and Hercynian, formed at two different periods, gradually converge upon one another towards the west until on reaching Wales they meet. On crossing over to the other side of the Atlantic it is remarkable to find that the crossing of these systems, begun in western Europe, is continued in eastern North America at exactly the point where it is left off in Europe, as pointed out by Prof. E. B. Bailey, a fact unlikely to be observed had the Atlantic represented an area of sunken land. As regards the countries bordering the South Atlantic, the eminent South African geologist A. du Toit has shown that the geological fit is very fair, provided we leave a gap of about 500 miles between South America and South Africa.

Not only did Wegener claim that his hypothesis of continental drift explained the facts referred to above—biological, geological and climatological—but he also used it to explain the great Tertiary period of mountain formation which gave rise to the present great mountain systems of the world. For he supposed that it was the westward drift of the Americas which crumpled up the western margin of the continent to produce the Andes in South America and the great coastal ranges in North America; while the north-easterly movement of India away from Africa was responsible for the crumpling of the soft deposits of the sea which lay between what is now India and the rest of Asia, to give the Himalaya. A defect in this which should be mentioned is that Alps seem to have suffered as much crumpling as the Himalaya, and yet to move Africa as far north as Wegener moves India would completely spoil the Atlantic fit. The orthodox explanation of the formation of mountain ranges was to attribute them to the crumpling of the earth's crust consequent upon its cooling and contraction. But it can be shown that the amount of crumpling observed in the better known mountain ranges is far in excess of the total diminution in the circumference of the earth which can ever have been due to cooling. Moreover, the recognition of the part played by the disintegration of the radioactive elements, and the heat thus provided, makes it very doubtful if the earth has been uniformly cooling. And so Wegener's hypothesis explained yet another problem that had been worrying geologists. Is it a wonder then that this hypothesis, fantastic as it seemed at first, was received with open arms by

many scientists, and especially by those alpine geologists who had been impressed with the great foreshortening of the crust required for the formation of the Alps? But there has always remained one great obstacle to the full acceptance of the idea of continental drift, and that is there is no known force capable of producing this movement of the continents. Wegener postulated two forces, one acting towards the equator (producing the great meridional Alpine-Himalayan chain), and the other towards the west (producing the western American chains). But it can be shown that these forces, partly tidal in origin, are less than one-millionth part of the force required to tear the continents apart and move them over the face of the earth, though it is to be admitted that the time available is very great.

Summarily, the land bridge theory is open to the objection that it is inconsistent with the theory of isostasy; while for Wegener's theory of continental drift there is no known force adequate to do the work. Appeal to geological evidence, however, shows that both the sinking of continental tracts and the movement of continents have taken place in the past, at least to some extent, and facts of observation must be accounted more important than conclusions derived from theoretical arguments. Thus it is abundantly clear that there must have been sinking of the crust to the extent of many thousands of feet in those geosynclinal seas which became the sites of mountain ranges, in order to account for the continuous deposition of so great a thickness of comparatively shallow water deposits. It is difficult to understand the mechanism of such movement, but our President, Dr. Fermor, has put forward the enlightening suggestion that the underlying basalt may at times change to a rock of similar composition but greater density, such as eclogite, the local contraction involved in this change accounting for local subsidence. That this may be so is suggested by the curious earthquake phenomena which have from time to time characterized the earthquakes of Assam. There can be little doubt that actual sinking of the crust is taking place along the Brahmaputra valley, which is probably a rift valley separating the Assam plateau from the rest of India; and the fact that many of the earthquakes which take place in this area are not related to any particular epicentre, but seem to take place simultaneously over a large area, suggests that some sudden change is taking place in the rocks beneath the crust, a change which might well be of the nature of basalt to eclogite. The theory of isostasy has probably been considerably overworked in the past. It should not be regarded as the prime force in mountain formation, but only as a modifying influence which plays its part after the main action is over. Clearly what must happen, both during the geosynclinal period when subsidence is going on and during the subsequent phase of compression, is that the isostatic balance is temporarily thrown out of adjustment, and only towards the end does it restore the balance disturbed by the greater forces which have been in operation. Then as regards the difficulty of pointing to any force capable of moving the continents, an obvious answer to this objection is that a force which can compress the rocks to form great mountain ranges like the Himalaya should be competent to shift the continents as a whole. The very fact of folding implies horizontal movement. To take the case of the Himalaya, there can be no doubt whatever that Asia and India must have approached one another during Tertiary times to the extent of at least several hundred miles, to account for the observed folding; and if that amount of continental movement has to be admitted, then why not the greater drift required by Wegener?

As in all complicated problems, the difference of opinion which they give rise to generally leads to a solution which is a *via media*. As regards the question of the permanence of the oceans, the Atlantic is probably to be regarded as an ocean of comparatively recent origin, at any rate in its present form, and the same may apply to the Arabian sea; for there can be little doubt that the great plateau of Deccan trap must once have extended many miles westward of its present limit, now fixed by the coastline of Bombay. But the Pacific has the impress of greater antiquity, a conclusion supported by recent seismological researches. That there must have been continental movement of some kind on more than one occasion in the past has, I think, to be admitted. But whether it was just in the way pictured by Wegener is more open to doubt. The accurate determinations of longitude by wireless which are now being made should provide in ten or fifteen years

time definite evidence as to whether movement of the continents is now taking place. For one thing Wegener must be given the credit. He has provided a great stimulus to geological thought during recent years, and many of our present ideas on earth tectonics are directly attributable to him. The problem, although essentially a geological one, is also one which can only be adequately solved with the help of all the sciences, and it is for that reason that I chose it as the subject of an evening lecture before the Indian Science Congress.

Research Notes.

Investigations on Magne-crystallic Action. Part I.—Diamagnetics.

[K. S. Krishnan, B. C. Guha and S. Banerjee. *Phil. Trans. Roy. Soc.*, **A. 231**, 235, 1933.]

IN this paper the authors report an extensive investigation on the magnetic anisotropy exhibited by single crystals. The object of the research is to obtain information on the orientation of the molecules in the unit cell by means of magnetic measurements. This is made possible by the fact that the differences of susceptibility in different directions depend upon the orientation of the molecules and not on their position. The difference in susceptibility is directly measured by suspending the crystal in the uniform field of a large electromagnet with plane pole pieces. The crystal is attached to a moderately thin glass fibre of 7 to 8 mm. length, and the fine suspension fibre of quartz is attached at one end to the glass fibre and at the other end to a torsion head. The latter is so rotated that there is no torsion in the fibre when the direction of maximum susceptibility in the plane of oscillation is parallel to the field. The periods of oscillation, T and T', with and without the field being determined, the difference of susceptibility is calculated by the formula

$$X_1 - X_2 = \frac{T'^2 - T^2}{T^2} \cdot \frac{C}{H^2} \cdot \frac{M}{m},$$

where X_1 and X_2 are the maximum and minimum values of the gram molecular susceptibility of the crystal in the plane of oscillation, C is the torsion constant of the fibre, m the mass of the crystal and M its molecular weight.

The results of measurements made on a large number of crystals are given in the paper. The striking fact revealed by these data is the large magnetic anisotropy of the nitrates, carbonates and the chlorate, while the sulphates are more or less completely isotropic. The behaviour of the nitrates and carbonates is explained by the intrinsic anisotropy of the NO_3^- and $CO_3^=$ ions and the parallel orientations of all the ions in the crystal. The contribution of the metallic ions to the susceptibility seems to be isotropic. The anisotropy of the NO_3^- and $CO_3^=$ ions is stated to be probably connected with their plane structure; the fact that strong magnetic anisotropy is usually associated with optical anisotropy is thus explained. The isotropy of the $SO_4^=$ ion is also shown to be in agreement with the results of X-ray investigations. From the behaviour of the ClO_3^- ion it is concluded that the structure of this ion is probably pyramidal with Cl at the apex.

Measurements have also been made on a number of organic crystals, while their absolute susceptibilities have been determined so as to fill the gap in the existing data. A null method of the type used by Rabi (*Phys. Rev.*, **29**, 174, 1927) has been employed for the purpose The susceptibilities of the fused crystals have also been determined by the modified Quincke method used by Ranganadham. It has been found that there is no change in susceptibility on fusion in the case of naphthalene, while benzophenone showed a change of about 2·5%. Further experiments are promised with a view to discover if this difference in behaviour is connected with the dipole moments of the substances. Detailed discussions of the molecular orientation are given in the case of naphthalene, anthracene, biphenyl, dibenzyl, azobenzene, stilbene, β-naphthol and acenaphthene. It is concluded that magnetic measurements can yield the entire molecular orientations in the unit cell in favourable cases like biphenyl and dibenzyl, while in less favourable cases, some of the angular parameters that determine the orientations can be derived as in naphthalene and anthracene. Finally, the authors conclude that any structure proposed on X-ray or other considerations can be acceptable only when it is in agreement with the results of magnetic measurements.

Preliminary Observations on some Polychæte Larvæ of the Madras Coast and a Note on the Occurrence in Townet Water of the Larvæ of Chætogordius ? Moore.

PROF. R. GOPALA IYER deals with a collection of Polychæte larvæ (*Journ. Madras Univ.*, Vol. V, No. 1) obtained in townet water from the Madras coast. A general idea of the seasonal occurrence of the various larvæ is given and observations on the larval development of some of the common genera are also made. It is pointed out that *Mitraria* larvæ stand out first in point of numbers and they attain maximum number in August. *Spionids* come next and are characteristic of the plankton during the months of November and December and to a lesser extent in January. *Terrebellids*, represented by the post larval stages of *Loimia medusa*, have been observed to turn up with singular regularity about the middle of June and November. *Nephthyds* and *Phyllodocids* occur in fairly large numbers during the months of December and January while *Eunicids* and *Polynoids* have March and April as their favourite months. *Nereids*, never very numerous, could be picked up during February and March. *Chætosphærids* and *Chætopterids* occur in small numbers in November and March while *Magelonoids*, represented by the post larval stages of *Magelona papillicornis*, occur in November and January.

Observations on some of the developmental stages of *Phyllogoce*, *Nephthys*, *Eunice*, *Glycera*, *Eone*, *Chætosphæra*, *Chætopterus*, *Telepsavus*, *Magelona*, *Loimia*, *Capitella* and *Sabellaria* are given. Unfortunately in most of the above mentioned cases specific identification of the larvæ was not found possible. A fairly connected account of the larval development of what is probably a species of *Chætogordius* is also given.

Microscopical Study of some Indian Coals.

MICROSCOPIC examination of coal has been for some years an established branch of study in Europe and America and is being recognized as an useful adjunct to the study of coal seams. Mr. A. K. Banerji has published in the last issue of the *Records of the Geological Survey of India* (Vol. LXVI, p. 333) some highly interesting results derived by the microscopic study of some samples of Indian Gondwana and Tertiary coals, in which he employed the modern technique of coal petrography. Examination of two samples of gondwana coal has shown that woody stems contributed to some extent to the formation of the coals; they may, therefore, be said to have originated from tree-like plants. The presence of Araucarian pitting has been definitely established, while no scalariform tracheids characteristic of the *Filicales* has been observed. This seems to indicate a gymnospermous affinity of a portion at least of the flora, especially as megaspores are completely absent. One of the most striking features of the Indian tertiary coals is the relatively frequent occurrence of sclerotium bodies of certain fungi, partly differentiated into several cells and partly simple. It will be important to observe whether these bodies occur with the same frequency in the brown coals or lignites from other parts of the world.

The Relative Numbers of Immature Erythrocytes in the Circulating Blood of Several Species of Marine Fishes.

DAWSON, B. ALDEN, has made a comprehensive study of the blood of general circulation of twenty species of marine fishes (*Biol. Bull.*, **64**, 1, 1933), and has noticed that the number of immature erythrocytes varies widely. The differential erythrocyte counts were based largely on supravital preparations stained with brilliant creysl blue. The twenty species were divided into four groups and each group presented a varying count of immature erythrocytes. The variations were according to their mode of adaptations such as their type of external respiratory mechanism, the efficiency of their oxygen transporting system, their oxygen requirements and the oxygen tensions of their environments.

The Vellalas of Travancore.

THE article on Vellalas of Travancore by Mr. L. A. Krishna Iyer (*Journal of the Madras University*, Vol. V, No. 1, Jan. 1933) is an interesting contribution to South Indian Ethnology. They are an isolated group of early Dravidians retaining and practising some of the primitive social customs, eking out a scanty livelihood from agricultural pursuits. They are a poor community diminishing in numbers; the inhospitable areas which they inhabit smite

them with disease and cripple their energy. In personal appearance they have a dark complexion with an inclination to dolichocephaty head and a broad nose. Having lived in contact with the civilised Hindus, they have adopted their Gods for worship, their rules of inheritance, the panchayat system for settlement of disputes, funeral ceremonies and instincts of personal gold and silver ornaments. These are recent acquisitions. The physical anthropology of the primitive tribes of India is a field of study which is likely to yield fruitful results and before these interesting groups disappear, a comprehensive investigation should be undertaken. Ethnological investigations have revealed that social customs and habits, the superstitious faiths and religious practices, the code of morality and sex relations have had a parallel evolution among the primitive tribes and a comparative study of physical anthropology of the Indian primitive communities may throw light upon their origin, places of settlement, their lines of migration and the factors of differentiation.

On the Singularities of Laplace-Abel Integral.

IN the course of a lengthy memoir published in the *Math. Zeitschrift*. Band 29 (1929), Polya has discussed the properties of the integral $\int_0^\infty F(Z)e^{-zZ}dZ$ where $F(Z)$ is an integral function of what he calls "the exponential type" *i.e.* $|F(Z)| < Ae^{a|Z|}$. The paper published by P. L. Srivastava and S. P. Jain in the *Bulletin of the Academy of Sciences*, U.P., Vol. II, No. 2, Decr. 1932, considers instead of an integral function, an analytic function $\phi(Z)$ again of the exponential type, analytic in the region $|\text{amp } Z| < a\ (>0)$, and discusses what analogous results can be established for the integral $\int \phi(Z)\, e^{-zZ}dZ$. The introduction of a function $\lim_{P\to\infty} \frac{\log|\phi(Pe^{i\phi})|}{P}$ exactly analogous to what Polya calls the *indicator* leads to the required results.

Among some of the striking results are the following:

(1) If $f_1(s) = \int_0^\infty \phi(a+Z)e^{-sZ}dZ$, and

$$f_2(s) = \int_0^\infty \phi(b+Z)e^{-sZ}dZ,$$

where a and b are points inside the region wherein $\phi(Z)$ is analytic, then $f_1(s)$ and $f_2(s)$ have the same line of absolute convergence and the same singularities.

(2) A similar result for the series $f_1(s) = \sum_0^\infty \phi(a+n)e^{-sn}$ and $f_2(s) = \sum_0^\infty \phi(b+n)e^{-sn}$.

As a corollary, the singularities of the Dirichlet series $\sum_1^\infty \phi(\log n)n^{-s+1}$ and of the integral $\int_0^\infty \phi(Z)e^{-sZ}dZ$ are identical.

The authors' abstract of their paper has been published in the *Comptes Rendus*, Tome. 194, pp. 2111–2113. The authors call the integral $\int_0^\infty \phi(Z)e^{-sZ}dZ$ the Laplace–Abel integral. Is there a slip, Abel replacing Borel? The analogy of the integral to Dirichlet's series would justify the association of the name of Dirichlet as well.

Mitosis in Hydra. Mitosis in the Ecto-dermal-Epithelio Muscular Cells of Hydra.

CARL H. MCCONNELL describes the mitotic phenomenon in the ecto-epithelio-muscular cells of Hydra and the appearance of this kind of activity is exceptional (*Biol. Bull.*, **64**, 86, 1933). Interstitial cells divide mitotically and endoderm cells propagate themselves by amitotic divisions. The author has demonstrated nevertheless mitotic divisions in the ecto-epithelio-muscular cells. He has observed different stages of mitosis from prophase to telophase in about 205 preparations he has studied and thus establishes beyond doubt that mitosis is the rule rather than an exception. Mitotis figures are found in all parts of the body except the epithelio-muscular cells of the tentacles and are generally restricted to, or at least more numerous in, the upper two-thirds of the body. The centrioles and asters are present and the chromosome number is 12. It is further observed that mitotic phenomenon in Hydra occurs under all conditions.

According to previous observers the absence of mitotic division in the epithelio-muscular cells rendered their replacement by cells elaborated from the indifferent cells. The suggestion that an activity in the ecto- and endo-indifferent cells leading ultimately to cells which replace ecto- and endo-epithelio-muscular cells is denied on the basis of accurate observation. It is therefore suggested that the endo- and ecto-epithelio-muscular cells are self-propagating by a process of mitosis while the ecto- and endo-epithelial cells are concerned in the formation of sperm, egg and nematocysts among other functions.

The Nattukottai Chettiars.

DR. P. J. THOMAS has written an illuminating article on this community of indigenous bankers in the *Journal of the Madras University*, Vol. V, No. 1, January 1933. The Chettiars form a strong ethnic race of the Dravidian stock, distinguished for their extreme frugality and simplicity of habits, their strong individualism and spirit of enterprise, no less than their charitable disposition, religious endowments and munificent bequests to learning. The Indian Banking Communities, in addition to being money-lenders, are also merchants, commercial agents, landowners and managers of mills and factories; but the Chettiars as a rule avoid trade and other business concerns and if in recent years they have come to deal in gold or to occupy lands and plantations, they have been forced on them as unredeemed pledges. Though extremely thrifty in their personal comforts, they possess the primitive instincts of extravagant display of wealth as is evidenced by the total investment in houses and jewels amounting to about fourteen crores of rupees. It is estimated that the total capital employed by the Nattukottai community in their banking concerns is about rupees 120 crores, spread over Burma, Malay Peninsula, Straits Settlements, Ceylon, Cochin, China and Madras Presidency. The greater part of this working capital is derived from the proprietors and a small fraction of it is composed of deposits and advances and overdrafts from Joint-Stock Banks. The success of this community is due to their avoidance of all speculations and their interlocking of business interests which guarantees each other generous assistance in times of need. The custom of setting up a young married man in business either as a partner in old established concerns or independently has tended to promote independence and self-reliance among the members and the training in conservative business methods which a young apprentice receives fosters the traditional spirit of caution and shrewdness. Within recent years, the prominent members of this community like Sir Annamalai Chettiyar, Rajkumar Muthia Chettiyar have entered public life and have made notable contributions, and to the munificence of the former, one of the flourishing South Indian Universities owes its origin. Like the Jews of old, money-lenders have always suffered and in Indo-China where the Chettiyars have extensive banking interests, the decree-holders are threatened with expulsion from the French territory if they dared to execute the decrees against the offending debtors and an order of this nature on the part of the French Government in Saigon is likely to affect seriously the flow of trade and the availability of liquid money for the promotion of commerce. Dr. Thomas has made an important suggestion in regard to the future business of this important community. He has pointed out that private money-lending may not prove a profitable concern when the country is being rapidly industrialised and industrial investment is likely to prove of great benefit to their own interests and those of the country. This is especially so when it is remembered that an efficient system of large-scale industry is of prime importance for the prosperity of India and none can finance it with greater success than the shrewd and businesslike Nagarthars.

The Mechanism of Adaptation to varying Salinity in the Common Eel and the General Problem of Osmotic Regulation in Fishes.

(*P.R.S.*, Ser. B., **112**, 576, 1933.)

IT is of common knowledge that teleost fishes could live in fresh water and salt water as well. Ancel Keys in a very interesting article describes the various experiments conducted and the results. It is pointed out that the eel behaves as a fresh-water fish in a medium of fresh water and as a marine fish in sea water. Further the blood of the euryhaline species in sea water is practically indistinguishable in osmotic concentration from the blood of the stenohaline marine forms. Both types are capable of extracting water from

sea water and in the euryhaline fishes and fresh water teleosts the kidney assists in filtration. This point has been experimentally determined.

The Growth of the Nucleus in the Developing Egg of *Chlorohydra viridissimi.*

CONCERNING the development of the egg of Hydra, there have been various theories advanced by different schools of thought. It has been maintained by some authors that the eggs are differentiated from a few of the not too specialised interstitial cells, a majority of the latter being used as food for the developing egg. Only one egg ultimately reaches maturity. Carl H. McConnell makes the suggestion (*Biol. Bull.*, **64**, 103, 1933) that several functional eggs develop in the ovary simultaneously. The interstitial cells destined to develop into eggs are easily distinguishable from others by the size of the cell, the peculiar nucleus and the cytoplasmic contents. The fate of the nucleus of the developing egg has been studied and it apparently maintains a ratio of 1 : 9·66 to the cytoplasm. The cytoplasm ceases increasing in volume after the nucleus reaches a certain size. The nucleoli increase in number in relation to the size of the nucleus. The maturation process is heralded by the vacuolisation of the nuclear membrane and during the process of maturation the volume of the nucleus is an eighth of its volume prior to maturation.

Some Relict Races of *Cottus quadricornis* from Finland.

FROM a geological point of view Finland is very interesting and its numerous lakes, till very recently, formed part of the sea. Relict races of different forms of animals have been described from these lakes and not the least important are those of *Cottus quadricornis* examined by E. Lonneberg (*Ark. for Zool.*, Band 24, Haft 3, 1933). He finds certain differences between typical marine forms of *C. quadricornis* and the relict races from the different lakes of Finland, associating the absence of spinous scales and other secondary sexual characters to the lack of calcium salts in the waters of the lakes in which these fishes are obliged to live.

On the Respiratory Function of the Blood of the Porpoise.

GREEN, Arda A., and Alfred C. Redfield have set forth (*Biol. Bull.*, **64**, 44, 1933) experimental data obtained as a result of an examination of the physico-chemical properties of the respiratory fluids of these aquatic mammals. The properties of blood are very similar to those of the terrestrial mammals. The only clear-cut aquatic adaptation recognizable in the corpuscles of the cetacean and the sea-lion is the increased concentration of haemoglobin in the corpuscles. Aquatic life though it brings about morphological adaptive modifications does not significantly affect the physico-chemical properties of blood.

Science News.

The Chromosome Number of Cleome viscosa Linn.—DR. E. K. JANAKI AMMAL, D.SC., F.L.S., Department of Botany, College of Science, Trivandrum, writes:—

"Pollen mother cells of Cleome viscosa Linn. were crushed into a drop of acetocarmine solution as described by Belling (1926). The cytoplasm of the P.M.C.'s when viewed immediately after this treatment, showed large numbers of oil globules. These screened the nucleus so that the Chromosomes were not visible. When slides were set aside for about a couple of hours the globules disappeared and the chromosomes could be clearly seen. The metaphase plate showed the haploid number in Cleome viscosa to be 10.

Reduction division in P.M.C.'s occurred at about 9 A.M. in January and February."

* * *

M. CHARLES MARIE, Secretaire General, Societe de Chimie Physique, Paris, writes:—

"The Society of Physical Chemistry is going to celebrate its 25th Anniversary this year. Arrangements are made for festivities to take place in the 3rd week of October, such as usual: an assembly, receptions, a banquet, etc. The Society found it also desirable to profit of this occasion and to arrange a general discussion on one of the modern scientific points. The subject of the discussion is to be: 'Electron Theory of Metals—Electrolytes and the intermediate layers Electrode-Solution.'

A number of scientists, foreign and French, have been asked to contribute Reports. All those Reports are going to be printed and the proofsheets distributed to the Members of the meeting. In order to make this meeting an international one, the Reports are to be published in the author's native language: German, English, Italian or French.

The Society of Physical Chemistry should be extremely pleased to meet some of the Indian colleagues as members of the Congress. Applications have to be sent as soon as possible, eventually before June 30th, the beginning of the summer holidays, and not later than September 30th. The sum of 125 francs has to be adjoined, to cover the expenses of the receptions, banquet, etc., as well as the costs of the preliminary Reports, mentioned above.

The applications have to be forwarded at the address of the General Secretary, Dr. Ch. Marie, 9, rue de Bagneux, Paris (VI°)."

* * *

Mosquito and Charophyta.—DR. S. L. GHOSE, President of the Botany Section, 20th Indian Science Congress, writes:—

"The sentences quoted in Mr. Dixit's note are from a review on the Presidential Address of the Botany Section of the last Science Congress, and not from the address itself which evidently has not been read by Mr. Dixit. The following is an extract from the address and will speak for itself: 'In 1923 Vasconcelos drew attention to certain species of *Chara* which seemed to cause the death of mosquito larvæ by a poison which the latter obtained by feeding on them (100). In 1928, Messrs. Mathesan and Hinman published a paper on their observations on *Chara fragilis* in connection with mosquito and asserted that the plant growing in still and running water aquaria of various kinds prevented mosquito breeding (74). When the plant was decaying normal development of the larvæ took place, but when the plant recovered the larval growth was inhibited. Experiments on this alleged larvicidal property of the species of *Chara* have been recently made by Mr. Paul of Burma, Mr. Blow of England and Dr. Hamlyn-Harris of Australia (81, 9). These three workers seem to have got negative results. It is very desirable, therefore, that experiments should be made in our country, and the question of the larvicidal property of *Chara* species be finally settled, at least as far as India is concerned.'

One is glad to learn that Mr. Dixit has also given some attention to this problem and is able to confirm Mr. Pal's results. It will be very interesting, however, if he would publish a list of the species of *Chara* he has observed in this connection, especially of those from Santa Cruz which is said to be full of mosquitoes in spite of its vast areas being covered by Charophyta. The presence or absence of particular species of *Chara* may make all the difference. The following extracts from Mr. Pal's paper should be read along with the sentence quoted from it in Mr. Dixit's note: 'At the same time it appears to be a well-established fact that mosquito larvæ are absent from ponds containing Charophytes.....In my experience, likewise, similar conditions exist in Burma, and ponds containing mosquito larvæ do not contain Charophytes and *vice versa*.....It is just possible, of course, that the properties of different species, as far as destruction of mosquito larvæ is concerned, is different, and this may be an explanation of the contradictory results obtained by various workers. Unfortunately, *C. fragilis*, the species used by Mathesan and Hinman, was not available in Rangoon for experimental purposes. If it is really useful in the destruction of mosquito larvæ it would be worth while to introduce it to various regions.'

It is clear, therefore, that the problem is not definitely solved yet. The last sentence of Mr. Dixit's note, however, would assume that it is so and would tend to kill further research into the subject, and that is rather deplorable."

References.

(9) Blow, T. B., 'On the alleged larvicidal property of *Chara fragilis*'. *Proc. Linn. Soc. Lond.*, 1930-31, pp. 129-132.

(74) Mathesan, R., and Hinman, E. H., '*Chara fragilis*, and mosquito development.' *Amer. Journ. Hyg.*, VIII, 1928, pp. 279-292.

(81) Pal, B. P., 'Burmese Charophyta.' *Journ. Linn. Soc. Lond.*, XLIX, 1932, pp. 47-92.

(100) Vasconcelos, A. B., 'The algæ of the genus *Chara* and mosquito larva.' *Amer. Jour. Pub. Health*, XIII, 1923, p. 543.

* * *

Inhabitants of Waterfalls.—In his talk to the Rotary Club, Calcutta, on 27th. Sept. 1932, Dr. S. L. Hora enumerated the several interesting forms of animal life that have adapted themselves to this perilous habitat. A waterfall is a very unique blend of unusual factors and at first sight an impossible situation for animal life, it is truly surprising how many forms have made this their

home, adapting themselves in a remarkable manner to this dangerous situation. Of the fishes that live in or near waterfalls, the salmon is notable for its feats of leaping great heights to overcome obstacles in its ascent of a river. In India, the famous mahseer is said to be capable of similar feats.

For holding on to the substratum and thus withstand the rapidity of the stream, a variety of organs is developed in animals. In *Garra* the suctorial disc behind the mouth and the numerous adhesive pads developed by the skin in certain situations serve the purpose and this fish is capable of climbing up steep sides of a rock against a current to a height of nearly thirty feet. The tadpoles of *Rana afghana* bear similar adhesive suckers behind the mouth enabling it to withstand the fiercest currents. *Arges*, the South American Hill stream fish, uses its lips and ventral fins alternately for ascending vertical walls of rocks. In *Pseudecheneis* there is a broad corrugated adhesive disc on the ventral surface. The paired fins are used in *Balitora* and *Gastromyzon* for progression. The tadpoles of *Bufo penangensis* has its lips modified to form a powerful sucker. The same is the case in the tadpoles of *Helophryne* and *Ascaphus truei*.

Perhaps the most dangerous situation in a waterfall for animals to live in is its lip and here probably we meet with the profoundest modifications of animal body to enable it to cling to rocks. The *Blepharocerid* larvæ bear on the ventral surface a number of suckers capable of independent attachment and even help in locomotion. Associated with the *Blepharoceridæ* are the larvæ of *Deuterophlebia* which have developed seven pairs of abdominal outgrowths which enable the animals to grapple bare rocks. The nymphs of *Iron* has a most complex type of adaptive modifications. Its broad ventral surface applies itself to the substratum and its gill lamellæ provided with spinous pads enable the animal to cling to bare rocks very tenaciously.

Even the base of the fall which is one of the last situations where one expects animal life, has its fauna and while some live on the top of the rocks below exposed to the cataract, others rest at their sides. Of the former, the chiton-like larvæ of *Blepharocerids* are important, which by their flat bodies cling to the rocks and do not allow any water to flow underneath them. The pupæ of Caddis flies commonly occur on the sides of the rocks at the base of the fall.

* * *

Respiration in Fishes.—Dr. S. L. Hora's lecture at the Indian Museum on the 8th. December 1932 brings our knowledge of the respiration of fishes up to date. He has dealt with this intensely technical subject in a popular and attractive manner. There is a large number of fishes in India which have adapted their respiratory organs in diverse ways to their peculiar habitats and Dr. Hora has endeavoured to clear certain misconceptions about them, his personal observations on many of them being of great value. He describes at length the physiology of typical gill respiration and proceeds to consider the variations from this type. In the parasitic lampreys and hag-fishes, the gills are pouchlike and the gill openings serve both as exhalent and inhalent apertures. The spiracle, in the Skate, is used as the inhalent aperture, the water passing out through the gill apertures. In the Plaice also, the gill apertures serve both as incurrent and excurrent apertures. The way the respiratory organs are modified in hill stream fishes is truly remarkable. There really seems to be a correlation between the rate of movement (and the general activity) of the animals and that of the medium in which they live. In cases where the latter is markedly great, the former is inconsiderable and *vice versa*. It is well known that the flow of water in hill streams is very rapid and all the fishes have to do is to stick to a place. Accordingly and on account of the high oxygenation of the waters, the respiratory organs of hill stream fishes have become profoundly modified. Special grooves are developed in many of them along the corners of the mouth taking water to the gills and probably the extreme case is that offered by Sewellia where the rostral groove bears a special aperture through which the current of water probably enters the gill chambers.

In the remarkable Gyrinocheilus and Arges, the mouth is not used to take in water but the gill opening itself is divided into two parts,—an upper inhalent and a lower exhalent aperture. In both cases, the mouth is applied to the substratum and in no way aids in respiration. Amblyceps is another hill stream fish which has adapted itself to the varying water constitution of its streams. While during the rainy months, it is capable of respiring normally, diminished in oxygen, the animal can take in quantities of air into its gill chambers and thereby respire.

The case of Amblysceps leads us to more interesting forms where, instead of but a seasonal development, this air breathing habit has become a constant, permanent and accessory mode of respiration. The cases of Anabas, Clarias, Saccobranchus, Amphipnous and Ophiocephalus are too well known to us. In all these cases a variety of structures is developed to enable the animals to breathe air and what is probably more interesting is that in all these cases breathing air has become an indispensable necessity without occasional recourse to which the animals seem unable to live.

To Dr. Hora's list of Indian air breathing fishes can be added with advantage a small brackish water fish, Rhyncobdella, occurring in Calcutta. The normal mode of respiration of this fish is by means of gills. The gill-cover, however, bears along its posterior border, tiny serrations, which, on application to the body wall, close the gill aperture effectively. The fish is occasionally seen to come to the surface, take a bubble of air through its mouth and transfer it to the gill chamber whose walls are highly vascular and which is now closed in the manner described. Retaining this little bubble of air in its gill chamber, which now bulges out just as in Amblyceps the fish moves about beneath the surface. After a few minutes the gill cover is lifted, the bubble escapes and the fish resumes its usual method of gill respiration. Even here, air breathing has become indispensable, for as Day observes, the fish conceals itself in mud and becomes drowned in water if unable to reach the surface, as it apparently requires to respire air directly.

What bearing the development of an air breathing habit has on the origin and evolution of terrestrial vertebrates cannot be stated with

definiteness but that the air breathing habit was developed as an adaptation to the varying modes of life of fishes is certain.

* * *

MR. N. R. RAGHUNATHACHARI of the Maharajah's College, Vizianagaram, writes:—"With reference to scorpions, the Cambridge Natural History says that they live upon centipedes, insects and spiders, which they kill by their sting before eating. The incident which is now recorded corroborates the fact. Mr. V. Subba Rao, Electrician of the Vizianagaram Fort Power House, saw a scorpion (a species of Buthus) in the act of eating a centipede (a species of Scolopendra) at 8-30 A.M. on the 19th. instant. The arachnid was clinging half-way up a wooden door of the Power House. For nearly 30 minutes the scorpion did not move from the spot and was busy with its work. It was photographed in action. The head of the centipede's body was eaten away, leaving no remnants. The scorpion held the prey by the pedipalps, often taking it away from the mouth and then bringing it near."

* * *

With reference to the article "The Problem of the Lantana" by Mr. A. V. Varadaraja Iyengar (*Cur. Science*, **1**, 266, 1933), Messrs. M. SAYEEDUDDIN and M. ABDUS SALAM of the Botany Department, Osmania University College, Hyderabad, write:—"Lantana camara is found all over the Dominions, especially along roadsides and waste places. It is very interesting to note that in the majority of cases where there is cactus there is lantana present. Careful examination of lantana and cactus where they grow side by side reveals that the roots of the former remain quite separate from those of the latter. There is neither symbiosis nor parasitism. The only explanation we can offer at this stage is, that the habitat of both the plants is the same, and that they are xerophytes of common habits, and hence prefer similar environment. There is very little difficulty or hardly any in regarding lantana xerophyte owing to the facts that its leaves are more or less leathery, covered with fine hairs. The stem too is covered with hairs and studded with prickles. One more point in its favour is that the foliage is rather scanty which also helps in placing it amongst the xerophytes. It is for this reason that it is so hardy. We are not quite sure if the soil analysis will help us in clearing this up. Possibly by such an examination some relationship as to its surroundings may be established. Some more observations are being made on the characters and the association of these two plants.

About the uses of lantana, we have just to say a few words. As far as we are aware of, we are still in the dark as to its medicinal properties. We know that lantana contains an alkaloid named "Lantanine", which is similar to quinine in its properties in so far as it depresses the circulation and lowers the temperature. Kirtikar mentions that intermittent fevers which have not yielded to treatment with quinine have given way under the use of 2 grams of "lantanine". We have used with a marked degree of success the oil from the leaves of Lantana to cure itchness of the skin. We believe that the oil could be used as a sort of antiseptic for wounds, etc. It is for the Biochemists to investigate further into the properties of the oil, and the uses to which it can be put with success."

* * *

Origin of Leafy Sporophytes in Ferns.—Mr. G. P. Majumdar, Department of Botany, Presidency College, Calcutta, in the course of a communication writes confirming Coulter's homologous theory of alternation of generations among the sporophytes in ferns. He has given other citations in support of this observation.

* * *

Occurrence of Chert.—Reddipalayam, Tanjore. MR. T. N. MUTHUSWAMI of the Department of Geology, College of Engineering, Guindy, Madras, writes:—

"A band of Chert about 100 feet long has been observed at Reddipalayam, Tanjore, containing fossils of Lamellibranchs and Gastropods with some forams. Further studies are in progress as to its age in relation to the Cuddalore Sandstones."

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We acknowledge with thanks the receipt of the following:—

"Journal of the Indian Chemical Society"—Vol. 9, No. 12, Dec. 1932.

"Indian Forester"—Vol. 59, No. 3, March 1933.

"Nature"—Vol. 131, Nos. 3302-3305.

"Chemical Age"—Vol. 28, Nos. 711-714.

"Scientific Indian"—Vol. 9, No. 50, Feb. 1933.

"Proceedings of the Annual Meeting of the Asiatic Society of Bengal."

"Archiv Fur Zoologie"—Band 24, Hafte 3-4.

"Canadian Journal of Research"—Vol. 8, No. 1, Jan. 1933.

"Berichte der Deutschen Chemischen Gesellschaft"—66 Jahrg No. 3, March 1933.

"Journal of the Indian Mathematical Society"—Vol. 19, No. 12.

"Transaction of the Mining and Geological Institute of India"—Vol. 27, Part 4.

"The Quarterly Journal of the Geological Mining and Metallurgical Society of India"—Vol. 4, No. 3.

"Journal of General Chemistry"—(Russian Chemical Society) Vol. 2, No. 54, Parts 9 & 10.

Reviews.

THROUGH WONDERLANDS OF THE UNIVERSE. By R. K. Golikere. Demy 8vo. Pp. xviii + 400 with Frontispiece. D. B. Taraporevala Sons & Co., Hornby Road, Bombay. Kegan Paul & Co., London. Price Rs. 6-4-0.

The book deals with a variety of topics of geographical, geological, physical, astronomical and astrophysical nature. It begins with a short history of the earth, its geological formation and then gives a collection of strange finds in its interior. The next chapter is a collection of interesting facts about the hydrosphere, with a brief account of marine zoology at the end. Then follow chapters dealing with the land surface, volcanoes and the atmosphere, all written in the same strain. The chapter on the volcanoes gives a detailed account of the great eruption of Krakatoa in 1883. These accounts form about two-thirds of the book. The concluding chapters deal in a rather hurried fashion with the solar system, the galactic system, the physical condition of stars and the nebulæ. There is a small chapter on the projection of rockets to the moon and other worlds which forms thrilling columns in the newspapers, and we believe that this topic is sure to appeal to the popular mind. The subject of the finitude of space and of the expanding universe also find a place in the book, although this part seems to be too much overburdened with the opinions of Sir Arthur Eddington and Sir James Jeans.

The last two chapters give a brief account of the history of Astronomy in Asia and an account of the atomic theory and theory of evolution as conceived by the ancient Hindus. One would have liked to know how the Purāṇas reached the figure of 1,960,853,034 years regarding the age of the earth. Our author thinks that this figure compares favourably with those computed from recent scientific data, but one who is familiar with the various assumptions made in these computations should proceed rather cautiously with them.

On account of the large variety of topics dealt with, the book looks more like a compilation of facts than a systematic and unified presentation of the principles. The author must be however congratulated for having collected accurate and up-to-date information about such diverse subjects. It is refreshing to find that the author has not failed to notice the sensational happenings of the year of publication of the book, *viz.*, 1932. Such is for example the hypothesis of Neutrons. Again, the cosmic ray expedition to the Himalayas organized by Prof. Compton and led by Prof. Benade of Lahore which concluded in September last has not escaped the author's notice. One however misses illustrations, which more than anything else appeal to popular imagination. On the whole the author has been successful in his object of producing a book intended to awaken a taste for Science amongst laymen who ordinarily do not take any interest in it.

M. N. SAHA.

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CHEMICAL WAVE TRANSMISSION IN NERVE. By A. V. Hill, F.R.S. Pp. ix+74; 13 Figures. The Cambridge University Press, 1932. Price 5*sh.* net.

There are indeed few mathematically minded briiliant physicists who have adopted physiology of the muscle and nerve their special subject for research. Professor A. V. Hill, himself a mathematician and physicist, has in this as in his other contributions extended the application of the principles of physics to the elucidation of problems of neuro-muscular mechanism and phenomenon of conduction of impulse along a nerve fibre. This book based on the Liversidge Lecture delivered for the encouragement of research in chemistry is welcomed not only by chemists but also by physicists and physiologists. The ignorance of physicists and chemists, of the most elementary principles of biology which the author mentions in the preface seems to be quite true. The book deals with the nature of the problem and explains some elementary facts about nerves and nerve cells. A considered explanation of the nerve impulse on a physico-chemical basis is offered. It is emphasised that there is no transference of material substance along the nerve fibre during the passage of the impulse; it is to be regarded merely as a message. Since the signs of activity in a nerve usually recognized by the physiologial effects of sensation and response in an entire animal cannot be made use of in the study of isolated nerve fibres, the author describes the electrical change involved in the passage of an impulse in isolated therefore injured nerve fibres. In addition to the electrical change which

is of the order of a few hundredths of a volt, three other accompaniments of activity of a nerve—heat formation, oxygen consumption, and carbon dioxide production—are referred to in detail.

The source of heat produced is considered chiefly from the point of view of an electric disturbance and of surface phenomena. If it is imagined that some molecular change occurs over the whole surface by which energy is set free, the energy per molecule would be very small even compared with that of a quantum of visible light. The energy has been calculated also on the basis of a condenser discharge assuming that films constituting the dielectric of the condenser remaining "impermeable" when it is charged, and is at rest, but becomes conducting, permitting neighbouring areas of the film to discharge through it when once it is itself discharged. The origin of the resting potential is discussed taking the simplest case of a crab's nerve on the differential diffusion theory—potassium ions alone being able to penetrate the surface layer. The possible objections to this theory are considered.

The energy involved in the wave transmission in the nerve is compared to that associated with muscle contraction. The problem of transmission of impulses along the nerve is discussed on the basis of electrical excitation regarding a nerve fibre as a cylindrical condenser with a source of E.M.F. existing in the dielectric between the plates. Experimental evidence is adduced in support of the assumptions made. In dealing with crisis in electrical excitation the author offers to the physical chemists for solution a problem of fundamental importance with regard to the electrical discharge through a film accompanying "a rapid cycle of rise and fall of electrical conductivity".

The other factors concerning heat production are noted whilst suggesting other interesting problems connected with it.

There are the appendices explaining mathematically the excitation of nerve, the measurement of heat production and the energy of a nerve stimulus. There is a good bibliography and the book is well indexed. The author has undoubtedly placed physiologists and chemists under deep debt of gratitude by his lucid exposition of what is obviously a difficult subject.

A. SUBBA RAO.

* * *

ALTERNATING CURRENT ELECTRICAL ENGINEERING. By Phillip Kemp. Pp. xi+595. London: Macmillan & Co., Ltd., fourth edition, 1933. Price 15*sh*.

The fourth edition of this excellent textbook of alternating current engineering is substantially the same as the previous edition, but its value has been increased by the addition of new matter and the introduction of new diagrams. The chapter on transformers has been amplified by the addition of paragraphs relating to tap-changing on load, transformers for very high voltages and other matter relating to recent developments in transformer practice. In the chapter on alternators a revised treatment of armature reaction has been introduced with reference to actual wave shapes instead of sinusoidal waves. The theory of induction motor, already clearly explained in the previous edition, has been amplified and leaves little to be desired. The omission of chapters on transverters and transmission of power makes room for more important matter without any loss to the value of the book. The high hopes once entertained regarding the possibilities of the transverter have not been fulfilled, while the treatment of transmission of power in the previous edition was too sketchy to be of real use. The additional chapter on oscillatory circuits is welcome in view of the immense practical importance the subject has attained in recent years.

The chapter on three-phase commutator motors includes Schrage motor as in the previous edition; brief descriptions might also have been given of other types of motors belonging to the same class. In the chapter on rectifiers we should have liked to see some reference to the recent developments relating to the grid control of mercury-arc rectifiers as it promises to have far-reaching influence on the trend of electrical engineering practice in the future. Symbolic notation has been explained in a chapter at the end of the book. In view of the simplicity and wide use of the notation by other writers it would have been very helpful to the student if this chapter was introduced early and some use made of the notation throughout the book.

We feel sure that this very useful textbook willl remain the favourite of the student for many years to come.

F. N. M.

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SOME ASPECTS OF PLANT NUTRITION.

Rao Bahadur B. Viswa Nath, Agricultural Chemist to Government of Madras, has brought out a booklet on "Some Aspects of Plant Nutrition". It has been issued by the Society of Biological Chemists, India. Rao Bahadur Viswa Nath, who is a man of deep study and long experience, has made his publication interesting and thought-provoking. The subject of plant nutrition abuts on one hand on the subject of soil and on the other on that of animal nutrition. The author has dealt sufficiently with the soils and animal nutrition in order to make his review of the whole subject as complete as possible.

In a small book of about 40 pages it is impossible to go into details of any one of the subjects treated. It was the deep study of Rao Bahadur Viswa Nath that enabled him to condense in a few pages the history of the development of such subjects as soil-colloids, base exchange, soil organic matter, micro-biological population of the soil, the effects of mineral and organic manures on outturns and on the quality of seed produced, auximones and their importance, manuring and nutritive value of crops and the relation of organic manures to animal nutrition. In dealing with each of the subjects he has mentioned all the important work done so far and has at the end of the booklet given a full bibliographical index which will be of great help to the research workers on those subjects.

The booklet is so well written and is so full of information and inspiration that every one interested in the problems connected with plant and animal nutrition should have a copy which is available for one Rupee.

D. L. S.

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ELECTRICITY ON THE POULTRY FARM. By L. J. Smith and Harry L. Gawer. State Agricultural College, Pullman, Washington, D. C.

This is a bulletin of 71 pages giving latest and useful information from scientific and economic points of view regarding uses of electricity on poultry farm. The subjects discussed in popular language are poultry house lighting from the point of view of lengthening light during winter months, the beneficial effects of ultra-violet light on egg-laying, candling eggs, time saving and economic use of electrical machines for feed mixers, incubation, brooders, water heating for poultry houses during winter, ventilation with heated air, semi-scalder, control of cannibalism by use of Mazda lamp and refrigeration for storage of eggs. Systems of wiring for general poultry yard lighting and burglar alarm installation are explained. The above are economical when poultrying is done on a ranching scale but not for back-yard poultrying. Refrigeration from the point of view of cooling poultry houses and incubation room has not been worked out, but this aspect is of importance to Indian conditions. It would be interesting for Indian agricultural departments to study this bulletin and work out practical suggestions regarding agricultural machinery and implements for use of the ryots.

T. M.

Coming Events.

Societe de Chimie Physique, 25th Anniversary, October 1933.

General Title: The Electron Theory of Metals —Electrolytes and the intermediate layers, Electrode Solution.

PROVISIONAL LIST OF CONTRIBUTIONS.

1. M. le Professeur Brillouin, College de France, Paris (5°). "Theorie de la Conductibilité des Metaux."
2. M. F. Bloch, Privat-Docent, Institut fur theoretische Physik, 5, Linnestrasse, Leipzig C.1. "Les Electrons dans les Métaux —Propriétés Statiques—Magnétisme."
3. M. le Professeur V. Henri, Universite de Liège. "Energie d'Ionisation et affinité electrique des ions négatifs simples et complexes."
4. M. le Professeur Joffé, Institut Physicotechnique, Sosnowka 2, Leningrad. "Conductibilité des Solides mauvais conducteurs."
5. M. le Professeur E. K. Rideal, Dept. of Colloidal Science, The University, Cambridge. "Phase Boundary Potentials."
6. M. le Professeur M. Volmer, Institut f. physikalische Chemie und Elektrochemie., Charlottenburg, Berlinerst. 171. "Das elektrolitische Wachstum der Krystalle."
7. M. le Professeur P. Debye, Physikalisches Institut der Universitat, Leipzig.
8. M. le Professeur N. Bjerrum, Institut Royal vétérinaire et agronomique de Copenhague, 21 Rolighedavej. Sujet réservé.
8. M. le Professeur P. Dutoit, Université de Lausanne. "Le Potentiel Métal-solution dans les divers solvants."
9. M. R. Audubert, Directeur de laboratoire à l'Ecole Pratique des Hautes Etudes, Institut de Chimie, 11 rue Pierre-Curie, Paris (5°). "Action de la lumière sur le Potentiel Métal-Solution.".
10. M. le Professeur F. Dubois, Université de Clermont-Ferrand (Puy-d-Dôme). "L'Effet Volta."
11. M. A. H. Wilson, Emmanuel College, Cambridge. "The electrical properties of semiconductors and insulators."
12. M. le Professeur A. Gillet, Université de Liège. "Les Colloides et la couche de passage."
13. M. le Professeur O. Scarpa, Milan. "Les différences de potentiel engendrées aux contacts entre métaux par diffusion des ions et électrons. (Pilles métalliques isothermiques).
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